# TENDER DOCUMENTS

# SUBSECTION 6.41
# STEELWORK

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## SUBSECTION 6.41 STEELWORK

### 6.41.1 GENERAL

6.41.1.1 This subsection describes the requirements relating to the steelwork covered by this Contract.

6.41.1.2 Any specific requirements pertaining to the steelwork covered by this Contract are set out on the drawings and in Section 4 *Special Technical Conditions*.

6.41.1.3 Any requirements relating to painting are described in subsection 6.42 *Painting.*

### 6.41.2 MEASUREMENT UNITS

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

| Measurement Unit | Designation | Symbol |
|---|---|---|
| stress, pressure | megapascal | MPa |
| length | meter | m |
| length | millimeter | mm |
| length | micrometer | µm |
| pressure | kilopascal | kPa |
| temperature | degree Celsius | °C |

### 6.41.3 REFERENCE STANDARDS

6.41.3.1 The **Contractor** shall carry out all steelwork in accordance with the requirements of the following standards and documents to which the provisions of this Contract are added:

6.41.3.1.1 (AASHTO) American Association of State Highway and Transportation Officials:

- AASHTO/AWS D1.5 *Bridge Welding Code*.

6.41.3.1.2 (ACNOR (CSA)) Canadian Standards Association:

- CAN/CSA G40.20/G40.21 *General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel;*
- CAN/CSA S6 *Canadian Highway Bridge Design Code*;
- CAN/CSA S16 *Limit States Design of Steel Structures;*
- CAN/CSA W47.1 *Certification of Companies for Fusion Welding of Steel;*
- CAN/CSA W48-F06 *Filler Metals and Allied Materials for Metal Arc Welding;*
- CAN/CSA W59 *Welded Steel Construction (Metal Arc Welding);*

- CAN/CSA W178.1 *Welding Inspection Organizations Company Certification*;
- CAN/CSA W178.2 *Certification of Welding Inspectors*;

6.41.3.1.3 (ANSI) American National Standards Institute / (NAAMM) National Association of Architectural Metal Manufacturers:

- ANSI/NAAMM MBG 531-00 *Metal Bar Grating Manual.*

6.41.3.1.4 (ASME) American Society of Mechanical Engineers:

- ASME B18.21.1 *Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).*

6.41.3.1.5 (ASTM) ASTM International:

- ASTM A53/A53M *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless;*
- ASTM A108 *Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished;*
- ASTM A123/A123M *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*;
- ASTM A143/A143M *Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement*;
- ASTM A153/153M *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware;*
- ASTM A193/A193M *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*;
- ASTM A307 *Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength;*
- ASTM A325 *Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength;*
- ASTM A325M *Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength [Metric];*
- ASTM A434 *Standard Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered;*
- ASTM A449 *Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use;*
- ASTM A490 *Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength*;
- ASTM A490M *Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric];*

- ASTM A500/A500M *Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes;*
- ASTM A510/A510M *Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel;*
- ASTM A563 *Standard Specification for Carbon and Alloy Steel Nuts;*
- ASTM A563M *Standard Specification for Carbon and Alloy Steel Nuts [Metric];*
- ASTM A572/A572M *Standard Specification for High-Strength Low-Alloy Columbium – Vanadium Structural Steel*;
- ASTM A722/A722M *Standard Specification for High-Strength Steel Bars for Prestressed Concrete*;
- ASTM A780/A780M *Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings*;
- ASTM A1011/A1011M *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength;*
- ASTM F436 *Standard Specification for Hardened Steels Washers;*
- ASTM F436M *Standard Specification for Hardened Steel Washers [Metric];*
- ASTM F593 *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs;*
- ASTM F594 *Standard Specification for Stainless Steel Nuts*;
- ASTM F1554 *Standard Specification for Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength*;
- ASTM F1852 *Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength*.

6.41.3.1.6 (MTQ) Ministère des Transports du Québec:

- MTQ – *Cahier des charges et devis généraux* (CCDG) – *Construction et réparation*.

6.41.3.1.7 (ISO) International Organization for Standardization:

- ISO 9001 *Quality Management.*

6.41.3.1.8 (SSPC) Society for Protective Coatings:

- SSPC-SP 1 *Solvent Cleaning*;
- SSPC-SP 5/NACE No.1 *White Metal Blast Cleaning;*
- SSPC-SP 6/NACE No.3 *Commercial Blast Cleaning*;
- SSPC-SP 11 *Power Tool Cleaning to Bare Metal*.

## 6.41.4 MATERIALS

6.41.4.1 GENERAL

6.41.4.1.1 The structural steels shall comply with standard CAN/CSA G40.21.

6.41.4.1.2 The weather resistant steel alloy shall be Type A in accordance with standard CAN/CSA G40.21.

6.41.4.1.3 The fracture-critical members and primary tension members, if any, indicated on the drawings shall be made of Type AT, WT or QT steel, in accordance with standard CAN/CSA G40.21.

6.41.4.1.4 For AT, WT or QT steels and electrodes, the thermal and energy requirements for the Charpy V-notch test shall comply with Tables 10.12, 10.13, 10.14 and 10.15 of standard CAN/CSA S6.

6.41.4.1.5 All steel components shall be new and free of warps, rust and defects, such as cracks, nicks, ruts, welding splatters, notches or sharp edges.

6.41.4.1.6 Unless otherwise indicated on the drawings, the **Contractor** shall ensure that the bolt and anchor rod threads are not intercepted by the shear planes.

6.41.4.1.7 The fabrication tolerances for the steel components shall comply with standard CAN/CSA S6.

6.41.4.2 STRUCTURAL STEEL AND HOLLOW STRUCTURAL SECTIONS

6.41.4.2.1 The steel indicated on the drawings shall have the following characteristics:

6.41.4.2.1.1 the steel used for plates and rolled members shall comply with standard CAN/CSA G40.21 and be of Grade 300W, 350W, 350WT or 350AT;

6.41.4.2.1.2 the hollow structural sections (HSS) shall comply with standard CAN/CSA G40.21, be of Grade 350W and Class H, or with standard ASTM A500/A500M be of Grade C;

6.41.4.2.1.3 the steel used for the main grating bars shall comply with standard ASTM A1011/A1011M. The steel for the transversal grating bars shall comply with standard ASTM A510. The materials and fabrication of the steel grating shall comply with standard ANSI/NAAMM MBG 531;

6.41.4.2.1.4 the steel for the railing pipes shall comply with standard ASTM A53/A53M. The steel for the railing pipes shall have a minimum yield strength of 207 MPa;

6.41.4.2.1.5 the steel for the tubular piles and caisson piles shall comply with standard CAN/CSA G40.21. The dimensional fabrication tolerances of the piles shall comply with the values indicated in Tables 11, 12, 15 and 17 of standard CAN/CSA G40.20;

6.41.4.2.1.6 the steel for H piles shall comply with Table 7 *Mechanical properties of rolled shapes and sheet piling* of standard CAN/CSA G40.21 or be of Grade 50 or 55 in accordance with standard ASTM A572/A572M.

6.41.4.3 STEEL BOLTS, ANCHOR RODS, NUTS AND WASHERS

6.41.4.3.1 The bolts indicated on the drawings shall comply with the following standards:

6.41.4.3.1.1 ASTM A325 and ASTM A325M

- Type 1: medium-carbon content steel bolts;
- Type 3: steel bolts with enhanced corrosion resistance.

6.41.4.3.1.1.1 The threads of the bolts shall be rolled.

6.41.4.3.1.2 ASTM A490 and ASTM A490M

- Type 1: steel alloy bolts;
- Type 3: steel bolts with enhanced corrosion resistance.

6.41.4.3.1.2.1 The threads of the bolts shall be rolled.

6.41.4.3.1.3 ASTM F593

- Stainless steel bolts, 304 or 305 alloy, for such applications as mounting a bracket on a pole;
- Stainless steel bolts stamped F593 C, D, G, H, L or M.

6.41.4.3.1.4 ASTM F1852

- Type 1: medium-carbon content steel bolts;
- Type 3: steel bolts with enhanced corrosion resistance.

6.41.4.3.2 The bolts and anchor rods indicated on the drawings shall comply with the following standards:

6.41.4.3.2.1 ASTM A307

- Grade A: general-purpose bolts and anchor rods;
- Grade B: bolts and anchor rods for assembling cast iron pipe mechanical joints;
- Grade C: bent or straight anchor rods for structural anchoring.

6.41.4.3.2.2 ASTM A193/A139M

- Grade B7: high-strength anchor rods.

6.41.4.3.2.3 ASTM A434

- Grade BB or BC: high-strength steel alloy anchor rods. The minimum yield strength and the minimum tensile strength shall comply with standard ASTM A449, taking into account the diameter of the rods to be fabricated. The tensile strength shall be less than 1,000 MPa. The welding of such steel is prohibited. The nuts shall be Type DH in accordance with standard ASTM A563 or A563M.

6.41.4.3.2.4 ASTM A449

- Type 1: medium carbon content anchor rods. The tensile strength shall be less than 1,000 MPa. The welding of this steel is prohibited;
- Medium carbon content steel bolts. The hot dip galvanized round-headed bolts are used to retain the sliding elements made of steel tubes.

6.41.4.3.2.5 CAN/CSA G40.21

- Grade 350W steel: for such applications as anchor rods on signage and lighting structures.

6.41.4.3.3 The U-bolts indicated on the drawings for signage structures shall comply with the following standards:

6.41.4.3.3.1 ASTM F593

- 300 Series alloy stainless steel bolts.

6.41.4.3.4 The specifications of the nuts indicated on the drawings shall conform to the following standard:

6.41.4.3.4.1 ASTM A563 and ASTM A563M

- The nuts to be used are those identified as “Recommended” in Table X1.1 “Nut and Bolt Suitability Guide” of the aforementioned standards.

6.41.4.3.4.2 ASTM F594

- Stainless steel nuts to be used for bolts and threaded rods compliant with standard ASTM F593.

6.41.4.3.5 The specifications of the washers indicated on the drawings shall comply with the following standards:

6.41.4.3.5.1 ASTM F436 and ASTM F436M

- Type 1: carbon steel washers;
- Type 3: steel washers with enhanced corrosion resistance.

6.41.4.3.5.2 ASME B18.21.1

- Standard washers;
- Lock washers.

6.41.4.3.6 The shear studs shall comply with standard CAN/CSA S6.

6.41.4.3.7 The nuts and washers shall have the same finish as the bolts and anchor rods.

6.41.4.3.8 The bolts shall not be reused.

6.41.4.3.9 The metric bolts may be replaced with imperial bolts provided the nuts and washers and the tools used are the same gauge.

6.41.4.4 HIGH-STRENGTH STEEL BARS

6.41.4.4.1 The high-strength steel bars shall be new, have a nominal tensile strength of 1,030MPa, and comply with standard ASTM A722/A722M.

6.41.4.4.2 All accessories, including the anchor plates, washers, nuts, couplers shall also be supplied by the manufacturer of the high-strength steel bars. The high-strength steel bar anchor plates shall be made of Grade 350W steel and shall comply with standard CAN/CSA G40.21.

6.41.4.4.3 Every batch of high-strength steel bars delivered to the worksite shall have an individual batch number and bear a label from the manufacturer so as to accurately be able to identify each batch at the worksite and the date of delivery. Any steel received at the worksite without being identified will be rejected.

6.41.4.5 WELDING ELECTRODES

6.41.4.5.1 The welding electrodes shall be basic electrodes compliant with standard CAN/CSA W48.

6.41.4.5.2 The storage and preparation of the electrodes shall comply with standard CAN/CSA W59.

6.41.4.6 METALLIZATION

6.41.4.6.1 The metallization process shall comply with standard ASTM A780/A780M.

6.41.4.6.2 The zinc thickness shall be at least 250 µm.

## 6.41.5 SOURCE OF STEEL

6.41.5.1 CERTIFICATE OF CONFORMITY

6.41.5.1.1 Structural steel

6.41.5.1.1.1 For each delivery of steel at the manufacturer's plant, the **Contractor** shall, for each production batch, provide the Engineer with a certificate of conformity containing the following information:

6.41.5.1.1.1.1 name of the steel mill;

6.41.5.1.1.1.2 date and place of fabrication;

6.41.5.1.1.1.3 nominal dimensions;

6.41.5.1.1.1.4 grade of steel;

6.41.5.1.1.1.5 thermal and energy requirements (Charpy V-notch test);

6.41.5.1.1.1.6 heat number;

6.41.5.1.1.1.7 analysis and test results;

6.41.5.1.1.1.8 production batch number.

6.41.5.1.1.2 A production batch consists of structural steel parts of the same grade, same notch toughness and same dimensions, and from the same heat.

6.41.5.1.2 Steel bolts, anchor rods, nuts and washers

6.41.5.1.1.2 For each delivery of steel bolts, anchor rods, nuts and washers, the **Contractor** shall, for each production batch of each part, provide the Engineer with a certificate of conformity containing the following information:

6.41.5.1.1.2.1 name of the manufacturer;

6.41.5.1.1.2.2 date of fabrication;

6.41.5.1.1.2.3 identification of the marking;

6.41.5.1.1.2.4 nominal dimensions;

6.41.5.1.1.2.5 steel grade or ASTM designation;

6.41.5.1.1.2.6 type, alloy or grade;

6.41.5.1.1.2.7 heat number;

6.41.5.1.1.2.8 compliance with the rotational capacity test for the galvanized bolts;

6.41.5.1.1.2.9 analysis and test results;

6.41.5.1.1.2.10 information on the coating;

6.41.5.1.1.2.11 production batch number. For assembled bolts, the batch number of each part, bolts, nuts and washers, shall also be provided.

6.41.5.1.1.3 A production batch consists of parts, steel bolts, anchor rods, nuts and washers from the same heat of steel, of same dimensions and from the same sequence of operations.

6.41.5.1.3 For each delivery of studs and at least fourteen (14) days prior to use thereof, the **Contractor** shall provide the Engineer with a certificate of conformity indicating that the studs comply with standard CAN/CSA S6 and that they appear on the list of stud bases qualified by the Canadian welding Bureau (CWB).

6.41.5.1.4 The samples used for the physical tests shall be available from the steel mill for inspection thereof by the Engineer.

6.41.5.2 STOCK STEEL

6.41.5.2.1 Where stock steel is used, the **Contractor** shall confirm the quality of the materials by providing the Engineer with the manufacturer's stamps and certificates guaranteeing that the steel meets the requirements prescribed in this subsection.

6.41.5.2.2 The Engineer reserves the right to select parts to undergo testing at the **Contractor**'s expense.

6.41.5.2.3 If test certificates cannot be obtained from the steel mill for all the stock steels, the **Contractor** shall provide the Engineer with a certificate attesting that the steel meets the prescribed requirements.

6.41.5.3 IMPORTED STEEL

6.41.5.3.1 The **Contractor** shall provide the Engineer with a certificate of conformity to the prescribed requirements of this subsection, signed by the recognized Canadian steel supplier, for any steel imported from countries other than the United States of America.

6.41.5.4 MARKING OF THE STEEL

6.41.5.4.1 The structural steels shall be marked in accordance with standard CAN/CSA G40.21.

6.41.5.4.1.1 In the case of products comprising several heat numbers, these numbers shall be supplied along with the information as to where they are located on the part.

6.41.5.4.2 For tubular piles and caissons piles, each tube shall be marked in accordance with standard CAN/CSA G40.21.

6.41.5.4.3 For H piles, each profile shall be marked in accordance with standard CAN/CSA G40.21 or standard ASTM A572/A572M.

6.41.5.4.4 The bolts, nuts, washers and anchor rods shall be marked in accordance with the reference standard governing the product.

6.41.5.5 STEEL TESTING METHODS

6.41.5.5.1 The steel shall be tested in accordance with the methods indicated in the current applicable ASTM standards.

6.41.5.5.2 The thermal and energy characteristics for the Charpy V-notch test shall comply with standard CAN/CSA S6. The test temperature "$T_t$" used for the Charpy V-notch test is:

6.41.5.5.2.1 of -20ºC for the steel of the members that are considered primary tension members;

6.41.5.5.2.2 of -30ºC for the filler metal.

6.41.5.6 DELIVERY, HANDLING AND STORAGE

6.41.5.6.1 All necessary precautions shall be taken to ensure that the steel elements are not damaged during shaping, transportation and assembly. Specifically, the **Contractor** shall ensure that:

6.41.5.6.1.1 the element edges are not nicked;

6.41.5.6.1.2 the elements are not subjected to excessive stresses;

6.41.5.6.1.3 the protective wedges required during transportation, lifting and storage of the elements are supplied and installed;

6.41.5.6.1.4 no part of any steel element comes into contact with the ground;

6.41.5.6.1.5 the parts and protective coating thereof are protected from any damage.

6.41.5.7 DELIVERY CONTROL

6.41.5.7.1 The Engineer reserves the right to carry out a delivery control of the steel elements in accordance with standard CAN/CSA G40.21.

6.41.5.7.1.1 The plates or profiles shall be big enough to allow the collection of 200 mm by 75 mm samples; the 200 mm dimension shall be in the direction of the rolling.

6.41.5.7.1.2 The marking of the heat number on the parts cut from plates shall be carried out in the presence of the Engineer.

6.41.5.7.1.3 A delivery control shall be carried out for the bolts subjected to tightening by turn-of-the-nut.

6.41.5.7.1.4 For each production batch of assembled bolts of the same ASTM designation, same type, same dimensions, same anti-corrosion characteristic and same heat of steel for each component, the **Contractor** shall check, in the presence of the Engineer, the minimum tension required on at least three (3) assembled bolts, bolt, nut and washer, according to the installation conditions specified in the bolting procedure submitted. Such checks shall be carried out with a calibration device capable of measuring the bolt tension and shall carried out prior to the installation of the bolts represented by the batch.

6.41.5.7.1.5 When carrying out the delivery control of the bolts, the **Contractor** shall use, in the device used for measuring the bolt tension, steel shims that are rigid enough not to deform during the tightening. These shims shall be as thick as possible so as to reduce the number thereof to a minimum. Furthermore, the steel shims shall be in full contact with each other and be selected so that the bolt end extends beyond the nut by approximately 3 mm. The use of assembled bolts, as an alternative to shims, is not allowed.

6.41.5.7.1.6 The sampling of the bolts, nuts, washers and anchor rods shall consist of three (3) pieces of the same type.

## 6.41.6 GALVANIZING

### 6.41.6.1 GENERAL

6.41.6.1.1 The process used for galvanizing metal parts shall be hot-dip galvanizing.

6.41.6.1.2 The galvanizing of the steel components shall be carried out in accordance with standards ASTM A123/A123M and ASTM A143/A143M.

6.41.6.1.2.1 However, the minimum galvanizing thickness required for the tubes, used in particular in steel restraint systems for major structures, safety barriers, drains and deck joints, is 100 µm.

6.41.6.1.2.2 All steel parts to be permanently installed shall, if they are not intended to receive a coating of paint or any other coating, be galvanized in accordance with the indications on the drawings.

6.41.6.1.3 The galvanizing of the bolts and anchor rods shall comply with standard A153/153M or standard ASTM A123/A123M, except for the bolts that meet the requirements of standard ASTM F1852.

6.41.6.1.4 The galvanizing of the nuts shall comply with standard ASTM A563 or standard ASTM A563M.

6.41.6.1.5 The galvanizing of the washers shall comply with standard ASTM F436 or standard ASTM F436M.

6.41.6.1.6 The bolts meeting the requirements of standard ASTM A490 or standard ASTM A490M shall not be galvanized and shall not have an electrolytic (electroplated) coating.

6.41.6.1.7 The anchor rods may be completely or partially galvanized on the threaded portion.

6.41.6.1.8 The bolted parts shall be galvanized prior to assembly.

6.41.6.2 SURFACE PREPARATION

6.41.6.2.1 The surfaces to be galvanized shall be clean, free of paint, grease, rust or other dirt. The residue deposits from welding, the scale and the paint or thick rust deposits shall be removed by suitable methods. The final stripping shall be done by immersion in a caustic solution, followed by clear water rinse and immersion in a bath of diluted sulfuric or hydrochloric acid. After stripping, the parts shall be immersed in an aqueous solution of zinc and ammonium chloride.

6.41.6.3 ASSEMBLIES OF DIFFERENT METALS

6.41.6.3.1 For an assembly of metal parts to be galvanized, the **Contractor** shall check whether the type of components and the configuration of the assembly may be problematic in terms of the density and thicknesses of the required coatings and shall, where required, apply the recommendations on the following surface preparation:

6.41.6.3.1.1 The parts cast in different metals forming a single assembly, such as cast iron, steel, malleable iron and steels of different compositions and surfaces that cannot allow a uniform coating of the complete assembly shall be grit blasted prior to galvanizing.

6.41.6.4 DELIVERY, HANDLING AND STORAGE

6.41.6.4.1 For each delivery of galvanized steel components, the **Contractor** shall provide the Engineer with a certificate of conformity, for each production batch, contain the following information:

6.41.6.4.1.1 the name of the galvanizing company;

6.41.6.4.1.2 the date and place of galvanizing;

6.41.6.4.1.3 the coating thickness;

6.41.6.4.1.4 the coating adhesion;

6.41.6.4.1.5 the quality of the coating.

6.41.6.4.2 The galvanized parts that come into contact with the lifting equipment, such as the cables and chains, shall be adequately protected. Non-metallized slings may, where appropriate, be used.

6.41.6.4.3 The **Contractor** shall protect the galvanized parts against any damage during handling and storage. The storage shall be done so that the air flows between the parts, water does not accumulate and drains freely and that there is no metal to metal contact between the galvanized parts. When installing the galvanized parts, the **Contractor** shall ensure that there is no white rust thereon.

6.41.6.5 REPAIR AFTER GALVANIZING

6.41.6.5.1 The **Contractor** shall remove the grease and oil on the damaged galvanized steel components using solvents in accordance with standard SSPC-SP 1.

6.41.6.5.2 Damaged surfaces up to 5 mm wide and up to 100 mm long shall be repaired by applying two (2) coats of zinc-rich paint with a brush, in accordance with standard ASTM A780/A780M. The damaged surfaces shall first be cleaned in accordance with the requirements of standard SSPC-SP 11. The minimum total thickness of the coating dry film shall be 130 µm.

6.41.6.5.3 Damaged surfaces wider than 5 mm or longer than 100 mm shall be galvanized again or repaired by metallization. In the latter case, the damaged surfaces shall first be cleaned in accordance with the requirements of standard SSPC-SP 5 or of standard SSPC-SP 11. The minimum thickness of the metallized coating shall be 10 µm.

6.41.6.5.4 The galvanized surfaces that were damaged during transportation or installation shall be repaired to the satisfaction of the Engineer by means of one of the following cold galvanizing products or equivalent approved by the Engineer :

6.41.6.5.4.1 *ZCR Cold Galvanizing Compoud,* distributed by Méta-plus for Kerry Industries;

6.41.6.5.4.2 *LPS Cold Galvanize,* distributed by Motion Industries;

6.41.6.5.4.3 *Galvicon,* distributed by Méta-plus for Kerry Industries;

6.41.6.5.4.4 *Rust Anode*, distributed by Galvatech 2000.

6.41.6.5.5 The galvanizing products shall be applied with a brush. Aerosol zinc-rich coatings are prohibited.

6.41.6.5.6 The zinc-rich cold galvanizing products shall be applied only to metal that is completely clean and dry. The **Contractor** shall remove the grease and oil with solvents before applying the zinc-rich product. The **Contractor** shall apply two (2) coats with a dry film thickness of at least 100 µm.

6.41.6.5.7 The welds shall be cleaned of the flux and protected with two (2) coats of one of the cold galvanizing products indicated in paragraph 6.41.6.5.4.

6.41.6.6 DRILLING IN GALVANIZED COMPONENTS

6.41.6.6.1 The drilling of holes in the galvanized steel members shall be carried out after galvanizing when the part is to be fixed according to the existing bolting pattern on the bridge. All holes shall be painted with a cold galvanizing product, in accordance with paragraph 6.41.6.5. The cold galvanizing product shall be dry before the assembly.

6.41.6.6.2 Drilling holes in the galvanized bridge bearings at the worksite is prohibited.

## 6.41.7 SHOP DRAWINGS

6.41.7.1 GENERAL STEEL WORKS

6.41.7.1.1 At least fourteen (14) days before any materials are ordered and any parts are fabricated, the **Contractor** shall submit to the Engineer, for review, the shop drawings and detailed design notes for the new steel structures and components; the drawings and notes shall be signed and sealed by an engineer member of the *Ordre des ingénieurs du Québec* (OIQ) and has at least five (5) years of experience in steel structures calculations.

6.41.7.1.2 The shop drawings shall include, without limitation, the following information:

6.41.7.1.2.1 the description of the working methods, temporary bracing and reinforcements, assembly steps as well as the type of equipment that the **Contractor** proposes to use for the transportation and assembly of the structural steel components;

6.41.7.1.2.2 the main dimensions, as well as the location of the different parts and identification mark thereof;

6.41.7.1.2.3 all shaping and assembly details, including the joints made in the workshop, cross-sections, counter-profiles, assemblies, holes, bearing plates, threaded anchors and rivets;

6.41.7.1.2.3.1 the **Contractor** shall clearly identify the holes to be drilled on worksite and those to be drilled in the workshop.

6.41.7.1.2.4 the calculations and drawings of the temporary supports, shoring and reinforcements proposed in accordance with the requirements of Article 6.41.8.2 *Temporary Supports, Shoring and Reinforcements.* The design loads shall be indicated on the shop drawings;

6.41.7.1.2.5 the number of the welding procedure and type of non-destructive examination of the welds in the tail of the welding symbol for each welded assembly;

6.41.7.1.2.6 the details of the layout and spacing of bolts.

6.41.7.1.3 The documents outlining the welding procedures and data sheets shall be approved and bear the seal of the CWB and shall be signed and sealed by an engineer member of the OIQ and has the qualifications described in paragraph 6.41.7.1.1.

6.41.7.1.4 The **Contractor** may not make any changes to the materials or construction details indicated on the shop drawings reviewed by the Engineer without prior written authorization from the Engineer.

6.41.7.1.5 All the values and dimensions given on the drawings shall be considered approximate.

6.41.7.1.6 Before preparing its shop drawings, the **Contractor** shall conduct a detailed worksite survey of all existing components in order to determine the exact dimensions thereof and validate the values and position of the assembly holes indicated on the drawings. The **Contractor** shall conduct such a survey in all the locations where a same detail applies.

6.41.7.1.7 The **Contractor** shall note that the dimensions of the steel components and layout of the bolts and rivets may vary from one location to another for each new construction and for each repair where the same detail is indicated on the drawings.

6.41.7.1.8 If, following the detailed survey of the parts, the dimensions obtained differ substantially from those indicated on the drawings or if the actual conditions do not allow for the work to be carried out as indicated on the drawings, the **Contractor** shall notify the Engineer thereof and follow his instructions.

6.41.7.1.9 The fact that the documents or components referred to in the foregoing paragraphs are reviewed by the Engineer does not relieve the **Contractor** from its responsibilities under this Contract, including, without limitation, its responsibility to supply proper materials and equipment, adopt suitable working methods and ensure of a good quality of execution of the works.

6.41.7.2 STEEL STRUCTURE FOR NEW DECK

6.41.7.2.1 At least fourteen (14) days prior to the fabrication meeting, the **Contractor** shall submit to the Engineer, for comments, the shop drawings of the new deck steel structure.

6.41.7.2.1.1 The shop drawings shall include the details of the main girder construction joints and show the location thereof if it is not indicated on the drawings. A design note and the details of the main girder construction joints that are not indicated on the drawings shall be sent to the Engineer prior to the preparation of the shop drawings. The design note and documents showing the details of the joints shall be signed and sealed by an engineer member of the OIQ.

6.41.7.2.1.2 The number of the welding procedure data sheet and the type of non-destructive examination of the welds shall be indicated on the shop drawings and, for the welds made on worksite, in the assembly drawings.

6.41.7.2.1.3 Once the fabrication of the steel structure completed, the **Contractor** shall provide the shop drawings in which is written the heat number of each part used in the fabrication of the main girders, primary tension members and other fracture-critical members.

6.41.7.2.2 At least fourteen (14) days prior to the worksite assembly of the new deck steel structure, the **Contractor** shall submit to the Engineer, for review, the assembly drawings.

6.41.7.2.2.1 The drawings and design notes of the assembly process, describing the method of installation of the components of the structure as well as the location and capacity of the equipment used, shall comply with standard CAN/CSA-S6, unless otherwise indicated on the drawings.

6.41.7.2.2.2 These documents shall include the temporary bracing and structures required to resist the loads during construction and to maintain the components of the structure stable and in their exact location until the completion of the structure so as to ensure the stability of the girders by preventing any lateral and longitudinal movement of the lower and upper flanges. The **Contractor** shall conduct a stability and strength study in order to ensure that the temporary loads due to the assembly of the structure or of any part of a structure as well as those produced during the pouring of the concrete slab, including the loads generated by the wind, do not cause stresses greater than those permitted, or conditions of instability of the structure, including the bridge bearings.

6.41.7.2.2.3 The **Contractor** shall consider all the loads that occur at the different stages of construction in accordance with standard CSA-S269.1, including the loads due to wind, set according to a return period of ten (10) years, a gust factor (Cg) of 2 and an exterior horizontal pressure coefficient (Cp) of 2. In the case of an overpass bridge, in order to take into account the local overloads generated by the traffic under the overpass bridge, the wind design pressures shall be increased by 0.24 kPa perpendicularly to the structure.

6.41.7.2.3 At least fourteen (14) days prior to the start of the worksite bolting of the new deck steel structure, the **Contractor** shall submit to the Engineer, for review, the procedure for the bolting of the components.

6.41.7.2.3.1 The bolting procedure shall describe the method used, by the **Contractor,** on worksite to install the bolts. This procedure shall include, without however being limited to, the description of the equipment used at each stage of the tightening and, for the main girder construction joints, it shall specify the method for adjusting the girder sections, as well as the sequence of installation and tightening of the bolts. In addition, the calibration certificate of the device used for measuring the bolt tension shall also be attached to the bolting procedure. This certificate shall contain the information relating to the device model and serial number and shall have been issued in the last twelve (12) months.

6.41.7.2.4 At least fourteen (14) days prior to the start of the factory fabrication and welding of the steel structure, the **Contractor** shall submit to the Engineer, for review, all documents relating to the factory fabrication and welding, without however being limited to:

6.41.7.2.4.1 the fabrication schedule;

6.41.7.2.4.2 the list of the persons assigned to the fabrication along with their qualifications, including the competency cards of the personnel making the welds, engineers, welding inspectors, welding supervisors, welders, tack welders, welding machine operators and persons responsible for ensuring quality control;

6.41.7.2.4.3 the qualification certificate of the company responsible for the welding;

6.41.7.2.4.4 the name of the welding inspection laboratory responsible for conducting the non-destructive examinations;

6.41.7.2.4.5 the welding procedures, including those for the studs, as well as those for the corrections and repairs, including the data sheets approved by the CWB. These documents shall be signed and sealed by an engineer member of the OIQ. The methods for the welding sequence, distortion control, preheating, post-heating, heating between passes, specification of the fillets, where welds are made under conditions in which tensile forces or distortion stresses may weaken the members or cause warping thereto, shall be part of the welding procedures. These methods shall be established by the **Contractor** in accordance with the standard CAN/CSA W59 or standard CAN/CSA W59.2 and shall be submitted to the Engineer for review;

6.41.7.2.4.6 the list of the steel structures designed in accordance with standard CAN/CSA S6 that the steel structure manufacturer has executed within the last five (5) years;

6.41.7.2.4.7 the list of the works that the steel structure manufacturer has executed within the last five (5) years, using the submerged arc welding process (SAW process) for the fillet welds at the main girder flange-web junction.

6.41.7.2.5 At least fourteen (14) days prior to the transportation of the girders from the factory to the worksite, the **Contractor** shall submit to the Engineer, for review, the documents relating to the transportation of the girders including, without however being limited to:

6.41.7.2.5.1 the documents relating to the support system of the through plate girders when they cannot be transported in an upright position. The **Contractor** shall submit to the Engineer, for information, the documents relating to the support system which detail the points of support of each girder. These documents shall be signed and sealed by an engineer member of the OIQ and consist in a design note and a support system plan. The design note shall present the results of a stability and strength analysis in order to ensure that the loads applied to the girder during transportation, due to its own dead load combined with a dynamic load factor of 100%, do not cause stresses greater than those permitted, or conditions of instability. In addition, the stresses shall not exceed the limit of the constant amplitude stress deviations ($F_{srt}$) associated to the fatigue detail category which governs the design of the girder. The maximum length of the cantilever shall not exceed twelve (12) times the width of the smallest girder flange;

6.41.7.2.5.2 the **Contractor** shall ensure that the design of the main girders complies with standard CAN/CSA S6.

6.41.7.2.6 The welding design shall meet the following requirements, without however being limited thereto:

6.41.7.2.6.1 the butt welds in a tension flange and in the web of the welded profiles (WWF and WRF) and plate girders shall not be located in locations where the stresses are maximum;

6.41.7.2.6.2 the minimum distance between a transversal stiffener and a butt weld in a flange or in the web shall be of 150 mm;

6.41.7.2.6.3 the minimum distance between the edge of a bolt hole and a butt weld in a flange or in the web shall be of 125 mm;

6.41.7.2.6.4 a butt weld in a flange for the welded profiles WWF and WRF and plate girders shall not be located within 300 mm of a butt weld in the web;

6.41.7.2.6.5 for the girders and girder sections that are shorter than 20 m, the flange and web plates shall be of a continuous length, without joints. When that length exceeds 20 m, a single butt weld in the flanges and the web is allowed, excluding those required by a change in flange thickness;

6.41.7.2.6.6 a girder web that can be fabricated from plates of a width of 3,800 mm or less shall not have any longitudinal joints;

6.41.7.2.6.7 the butt welds and longitudinal welds on an aluminum part are prohibited;

6.41.7.2.6.8 the signage or lighting structure welded assemblies between a post and an anchor plate shall be carried out by inserting the post into the anchor plate and by making two (2) peripheral fillet welds. In the case of aluminum assemblies, the post walls shall be pressed against the edge of the anchor plate. The permissible deviation between the post and the inner edge of the anchor plate is 0.5 mm over the entire circumference. These assemblies may also be made by full penetration peripheral welds with a fillet weld as groove weld solder buildup.

6.41.7.2.7 The design of the main girder construction joints shall meet the following requirements, without however being limited thereto:

6.41.7.2.7.1 the main girder construction joints that are not provided for on the drawings are not allowed for single span bridges whose span is less than 36 m;

6.41.7.2.7.2 the joints shall not be located where the stresses are maximum. If the stress diagram is not indicated on the drawings, the Engineer will give the **Contractor** the values of efforts at the location of the joint;

6.41.7.2.7.3 the joints shall be designed as slip-critical assemblies. The contact surfaces of the bolted parts shall be Class A for non-coated steel surfaces;

6.41.7.2.7.4 the steel of the joint plates and shims shall have the same yield strength and be of the same grade and same notch toughness as the steel of the girders;

6.41.7.2.7.5 the joint in the web shall further comply with the following requirements, without however being limited thereto:

6.41.7.2.7.5.1 in addition to the shear, the **Contractor** shall take into account, in the calculation the assembly, the portion of the moment taken by the web;

6.41.7.2.7.5.2 the shearing force shall be distributed evenly on all the bolts;

6.41.7.2.7.5.3 at the ultimate limit states, based on the distance between the two (2) bolts at the ends of a vertical line, a reduction factor shall be applied to the shear strength of the bolts;

6.41.7.2.7.5.4 the centre of rotation of the assembly shall be the same as the centre of gravity of the bolts;

6.41.7.2.7.5.5 as the assembly is eccentric in shear, the moment caused by the eccentricity of the shearing force shall be considered in addition to the portion of the moment taken by the web;

6.41.7.2.7.5.6 the shear load on each bolt shall be obtained by the vectorial addition of the forces caused by the shearing force, the moment from the shearing force and the portion of the moment taken by the web.

## 6.41.8 EXECUTION OF WORK

### 6.41.8.1 GENERAL

6.41.8.1.1 The **Contractor** shall provide all the labour and supply all the machinery, equipment, tools and temporary structures for the fabrication and installation of the steel components in compliance with the drawings and specifications.

6.41.8.1.2 All components shall be assembled and installed by workers holding “ironworker journeyman” competency cards issued by the *Commission de la construction du Québec* (CCQ) and having at least five (5) years of relevant experience in erecting steel structures.

6.41.8.1.3 The new components shall be fabricated so as to ensure a perfect fit with the existing components to be preserved.

6.41.8.1.3.1 If any existing components shall be straightened to ensure a perfect fit, they shall be cold-straightened. Hot-straightening is prohibited.

6.41.8.1.4 The modifying or welding of shop-made steel parts on worksite is prohibited. Any part that is modified or welded on worksite shall be dismantled and replaced with a new shop-made part.

6.41.8.1.5 The **Contractor** shall not damage or soil the components adjacent to the work areas and shall repair, straighten and clean, to the satisfaction of the Engineer, any component or part affected by the work.

6.41.8.1.6 When steel components are being replaced and the assembly details are not indicated on the drawings, the new assemblies shall be identical to the existing ones in terms of dimensions and number of bolts or rivets. The rivets shall, however, be replaced with bolts of the same diameter or of a diameter that is at the most 2 mm larger.

### 6.41.8.2 TEMPORARY SUPPORTS, SHORING AND REINFORCEMENTS

6.41.8.2.1 The **Contractor** shall ensure that the working methods used to replace the steel parts do not compromise the strength and stability of the parts or the overall integrity of the structure.

6.41.8.2.2 Before removing the rivets or bolts holding together the parts to be replaced or disassembled, the **Contractor** shall supply and install all temporary supports, shoring and reinforcements needed to ensure that the strength and stability of the structure are not affected and to ensure that the loads are properly transferred to the bearing components and foundations. These temporary reinforcement and support devices shall remain in place until the new parts are permanently installed.

6.41.8.2.3 The drawings of the temporary shoring structures submitted shall be signed and sealed by an engineer member of the OIQ.

6.41.8.2.4 The **Contractor** is entirely responsible for the design, supply, maintenance and removal of all temporary supports and devices.

6.41.8.2.5 The temporary supports and devices shall be designed in accordance with standard CAN/CSA S6. The temporary supports shall be designed to bear the dead load of the supported parts as well as any other load that is present on, or likely to be applied to the structure.

6.41.8.2.6 The reinforcement parts required to temporarily compensate for the absence of, or to allow for the disassembly of the bracing members and other members likely to take over the compressive or tensile loads shall be designed so as to offer the same compressive or tensile capacity than the replaced or temporarily disassembled member.

6.41.8.2.7 The temporary fasteners and reinforcements required to compensate for the partial disassembly of the end of members shall be designed so as to provide strength corresponding to the capacity of the disassembled components, including, without limitation, rivets, bolts and plates.

6.41.8.2.8 After the temporary reinforcements have been installed and before the steel parts of the structure for which the temporary reinforcement was installed have been removed, the **Contractor**'s design engineer shall issue an inspection report certifying that the temporary reinforcements comply with the temporary reinforcements drawings. The inspection of the temporary structures shall be conducted in the presence of the Engineer.

6.41.8.2.9 All loads, including the bending and shearing and torsionial forces, shall be taken into account in designing the reinforcements, shoring and supports.

### 6.41.8.3 SURFACE PREPARATION

6.41.8.3.1 The existing steel surfaces that will come into contact with the new steel shall be cleaned in accordance with standard SSPC-SP 11 in preparation for the application, by the **Contractor**, of a coat of primer to the interface and in order to obtain a better coefficient of friction.

6.41.8.3.2 The galvanized steel surfaces that are to come into contact with one another when the assembly is bolted together shall be cleaned manually with a wire brush in order to dull the finish without, however, affecting the zinc coating.

6.41.8.3.3 The cut edges of the steel plates and members shall be smooth and free of cracks, pits and breaks. The burrs and warps shall be removed by grinding. For parts to be painted or metallized, the sharp edges shall be rounded to a radius of at least 1.5 mm.

### 6.41.8.4 CUTTING AND DRILLING

6.41.8.4.1 Cutting and drilling of the metal parts on worksite with a blowtorch are prohibited.

6.41.8.4.2 Shear cutting is allowed only for steel sheets up to 20 mm thick where the steel has nominal yield strength below 350 MPa and is allowed only for steel sheets up to 16 mm thick where the steel has nominal yield strength of 350 MPa or more.

6.41.8.4.3 Cutting with a blowtorch in the shop shall be done using mechanical guides. The work shall be carried out continuously, without stop-start, so as to obtain an even cut surface.

6.41.8.4.4 The methods to be used to cut the steel on worksite shall be submitted to the Engineer, for review, prior to the work.

6.41.8.4.4.1 Cutting the ends of piles with a blowtorch for the preparation of butt assemblies is allowed to the extent that the method used by the **Contractor** is compatible with the relevant welding procedure.

6.41.8.4.5 The holes shall be drilled or made by shearing process or by an equivalent cold process authorized by the Engineer.

6.41.8.4.6 For assemblies carried out worksite, the holes shall be drilled with a bit to the final diameter using a metal template.

6.41.8.4.7 All holes made in the shop or on worksite shall be accurately drilled perpendicularly to the surface.

6.41.8.4.8 The bolt holes in the new materials necessary for the alignment and elevation adjustments shall be made in the workshop and shall be oblong.

6.41.8.5 REMOVAL OF THE RIVETS

6.41.8.5.1 The **Contractor** shall remove the rivets in accordance with the following requirements and ensure that the existing materials to be preserved are not damaged:

6.41.8.5.1.1 replace the rivets one at a time;

6.41.8.5.1.2 shear the rivet head using a pneumatic shear and remove the rivet rod using a pneumatic punch and/or by drilling with a magnetic drill. The **Contractor** shall ensure that the rivet head projected during the operation is recovered;

6.41.8.5.1.3 cutting the rivet head using a blowtorch is prohibited, unless authorized to do so by the Engineer;

6.41.8.5.1.4 repair, replace or restore, to the satisfaction of the Engineer, the steel structures damaged by the work;

6.41.8.5.1.5 the tightening method used to replace a rivet with a high-strength bolt shall be the turn-of-the-nut tightening method.

6.41.8.5.2 When rivets are being replaced with bolts, the **Contractor** shall provide for the fact that the holes in the steel parts are not perfectly aligned. Some of the holes in the existing parts will have to be reamed to allow for the installation of the bolts.

6.41.8.5.3 The diameter of the rivets to be replaced with bolts that is indicated on the drawings is given as an indication. The exact diameter of the rivets to be replaced is to be determined by the **Contractor** when the rivets are removed. The diameter of the bolts to use in replacement shall be equivalent to that of the rivets to be replaced.

6.41.8.5.3.1 The **Contractor** shall inform the Engineer of the diameters of the holes, once the rivets have been removed.

6.41.8.6 INSTALLATION OF HIGH-TENSILE STRENGTH BOLTS

6.41.8.6.1 The installation of high-tensile strength bolts shall comply with standard ASTM A325 or standard ASTM A490, as well as the indications on the drawings.

6.41.8.6.2 The bolt holes that are to be drilled in new materials and that shall be aligned with existing holes shall be cold drilled in the workshop to a diameter that is 6 mm smaller than the final dimension indicated on the drawings and shall be reamed on worksite to the final dimension needed after alignment and assembly.

6.41.8.6.2.1 If the misalignment exceeds 6 mm, the new steel will not be accepted and will have to be repaired or replaced by the **Contractor** at no additional cost to the **Owner**.

6.41.8.6.2.2 The diameter of the finished holes shall not be more than 2 mm bigger than that of the bolts to be therein inserted.

6.41.8.6.3 A template shall be used to drill new holes in the existing materials.

6.41.8.6.4 Unless otherwise indicated on the drawings, the bolt holes in the new materials necessary for the alignment and elevation adjustments shall be drilled in the workshop and shall be oblong.

6.41.8.6.5 The holes shall be aligned by means of pins, and the parts shall be held together by a sufficient number of pre-assembly bolts. A maximum of 20% of the holes on a given joint may be aligned using pins.

6.41.8.6.6 All bolt or rivet holes left empty once the new materials are in place shall be filled with new high-tensile strength bolts of the appropriate size.

6.41.8.6.7 Unless otherwise indicated on the drawings, the nuts shall be installed on the less visible side of the metal structure.

6.41.8.6.8 The installation and tightening of the high-tensile strength bolts shall be carried out in accordance with the procedure provided in Appendix 6.41-I *Requirements for Bolt Tightening* of this subsection.

6.41.8.6.9 In the event that the **Contractor** uses bolts that are tightened without control at the time of installation in order to allow, for example, the adjustment of parts to be assembled or to serve as temporary bolts, the **Contractor** shall provide for the replacement of these bolts with other new bolts in the final assemblies.

6.41.8.6.10 The **Contractor** shall, if necessary, before the final tightening, install shims between the new steel components and the existing members in order to ensure perfect contact between all components.

6.41.8.6.11 Any bolts that come loose after the final tightening shall be replaced with new bolts.

6.41.8.6.12 The threaded end of the bolts shall extend beyond the outer face of the nut, after the nut is tightened.

6.41.8.6.13 Unless otherwise indicated on the drawings or by the Engineer, the **Contractor** shall install washers in accordance with the following:

6.41.8.6.13.1 a hardened washer under the turned part;

6.41.8.6.13.2 a hardened washer under the part in contact with the existing steel, whether or not that part is turned;

6.41.8.6.13.3 the washers shall be beveled as needed to ensure perfect contact between all the components;

6.41.8.6.13.4 the bolts shall be painted on worksite after having been degreased, where paint is used as protective coating. Furthermore, when A490 and A490M bolts are used, they shall be painted on worksite after having been degreased;

6.14.8.6.13.5 The **Contractor** shall install a washer at each end of the bolts of an assembly comprising an oversized hole.

6.41.8.6.14 All temporary bolts shall be marked with red paint.

6.41.8.7 INSTALLATION OF THE HIGH-STRENGTH STEEL BARS

6.41.8.7.1 The tensioning of the high-strength steel bars shall be carried out in accordance with Appendix 6.41-II *Requirements for the Tensioning of High-Strength Steel Bars* of this subsection.

6.41.8.7.2 The tensioning of the high-strength steel bars shall be carried out by personnel who are competent in that field. Proof of competency of the proposed personnel shall be submitted to the Engineer prior to the commencement of the work.

6.41.8.7.3 The **Contractor**'s engineer shall ensure that the details of the high-strength steel bar tensioning method reviewed by the Engineer are applied safely and that no improvisation on worksite compromises the integrity of the structure and the safety of workers.

6.41.8.7.4 The **Contractor** is responsible for conducting all tests and for taking all the readings and measurements required to ensure the quality control of its tensioning work.

6.41.8.7.5 The **Contractor** shall provide the Engineer with the high-strength bars elongation values and thereto indicate the maximum allowable tensioning force. The **Contractor**'s engineer shall record the actual elongation values of the steels, any pressure exerted by the jacks and any tension loss at the anchors.

6.41.8.7.6 The **Contractor** shall periodically check the accuracy of the pressure gauge on the jack, by comparing it to another gauge mounted on the system.

6.41.8.7.7 The permissible deviation relative to the prescribed post-tensioning force shall not exceed 5%.

6.41.8.7.8 The tension in the steels shall be determined by measuring the elongation thereof, checked on a continuous basis by means of the pressure gauge on the jack or by any other system proposed by the **Contractor**.

6.41.8.7.9 The **Contractor** shall determine the traction zero-point error of the jack, where applicable, by taking a few direct readings of the elongation of the steels at the jack. These readings shall subsequently be plotted on a diagram and connected by a line. The zero-point error is estimated by extrapolating that line to the point where it intersects the horizontal axis.

6.41.8.7.10 The **Contractor** shall carry out the tensioning and limit it so as to obtain an effective prestressing force compliant with the drawings and with the values specified by the Engineer.

6.41.8.7.11 The post-tensioning elongation surveys and the readings of the tensile force and of the slippage of the cables shall be approved by the Engineer before the work is accepted.

6.41.8.7.12 A copy of the tensioning report signed by the **Contractor**'s engineer shall be sent to the Engineer at the end of the work.

6.41.8.8 WELDING

6.41.8.8.1 The shop welding shall comply with standard CAN/CSA W59.

6.41.8.8.2 The **Contractor** or subcontractors thereof, if any, that carry out welding work shall be certified by the CWB in accordance with standard CAN/CSA W47.1. Division 1 or Division 2 is required for steel metal structures; Division 3 is, however, sufficient for the deck joints, drains, interface drains, barriers, railings as well as for all the sealing welds of the deck joint bolted assembly joints.

6.41.8.8.3 The qualification certificate shall be obtained prior to the commencement of factory manufacture and, where applicable, prior to the commencement of the on-worksite welding work indicated on the drawings, and the certification shall be maintained throughout the duration of the fabrication or of the work on worksite.

6.41.8.8.4 The welders, tack welders and welding machine operators shall hold the competency cards that are appropriate on the basis of the welding position and of the type of electrodes and welding process used. Such competency cards shall be issued by the CWB in accordance with standard CAN/CSA W47.1. The welders shall have at least five (5) years of relevant welding experience.

6.41.8.8.5 Where the welds are made under conditions in which tensile forces or distortion stresses may weaken members or cause warping thereto, the **Contractor** shall submit to the Engineer, for review, the following methods:

6.41.8.8.5.1 method detailing the welding sequence;

6.41.8.8.5.2 methods used for controlling distortion, including, without limitation, the preheating, post-heating, heating between passes and specification of the beads, in accordance with the requirements of standard CAN/CSA W59.

6.41.8.8.6 The **Contractor** shall provide the detail of the specific preparations for welding along the edges of certain plates in order to ensure compliance with the prescribed standards.

6.41.8.8.7 The fillet welds shall have the minimum size in accordance with standard CAN/CSA S6 and shall be indicated on the shop drawings submitted by the **Contractor**.

6.41.8.8.8 The welds on existing steel components of the structure are prohibited, except to replace or to add a base plate.

6.41.8.8.9 Unless otherwise indicated on the drawings, the **Contractor** shall not carry out welding of any kind on worksite without having obtained the written authorization from the Engineer, and then only in the manner and in the locations designated in the authorization.

6.41.8.8.10 Prior to welding, the steel surfaces shall be cleaned to the bare metal. Where required, the cleaning to the bare metal shall include galvanizing. After welding, the **Contractor** shall remove the surface defects and grind the sharp edges. The **Contractor** shall further ensure that all flux and welding splatters are removed and, where needed, touch up the welds with a zinc-rich coating.

6.41.8.8.11 The welds shall be made prior to painting, galvanizing or metallization.

6.41.8.8.12 When welding is complete, the adjacent steel surfaces shall be brushed to remove any splatters and welding spatter that have not firmly adhered to the metal.

## 6.41.9 FABRICATION OF A STEEL DECK STRUCTURE

### 6.41.9.1 GENERAL

6.41.9.1.1 Unless otherwise indicated on the drawings, the fabrication of a deck steel structure shall comply with standard CAN/CSA S6.

6.41.9.1.2 At each major step of fabrication, such as the assembly of the flanges to the web, installation of the stiffeners and drilling of the parts, the Engineer shall review the reports establishing compliance with the drawings and the applicable standard prior to proceeding to the next step.

6.41.9.1.3 In the case of girders for which no camber is indicated on the drawings, the **Contractor** shall ensure that the camber resulting from the allowable fabrication tolerances is attenuated by the permanent loads.

6.41.9.1.4 The through plate girders shall not be cambered or hot curved.

6.41.9.1.5 The bracing, diaphragms and plates of the assembly joints shall be identified in order for them to be easily identifiable during the worksite assembly of the structure.

6.41.9.1.6 Before the parts are shipped from the factory, the steel surfaces of the structure made of Type A or AT steel that have not been covered with an anti-corrosion protection process shall be cleaned in accordance with standard SSPC-SP 6/Nace Nº 3.

6.41.9.1.7 Prior to the fabrication of the plate girder, a meeting involving the representatives of the **Contractor**, the manufacturer, and the Engineer shall be held in the offices of the manufacturer at least fourteen (14) days prior to the start of fabrication. In the case where the manufacturer entrusts all or part of the fabrication to one or more subcontractors, a preliminary meeting shall take place at the factory of each subcontractor, involving the same people in addition to the representatives of the subcontractor. The agenda shall include a tour of the factory and delivery of the required documents. The meeting with the manufacturer shall only take place once the shop drawings have been reviewed by the Engineer and where it is the case, after delivery to the Engineer of the list of the manufacturer's subcontractors.

6.41.9.2 CUTTING

6.41.9.2.1 At the factory, cutting the plates with a blowtorch or by means of laser or plasma shall be done using mechanical guides. The work shall be carried out continuously, without stop-start, so as to obtain an even cut surface, while respecting the specifications and usage limits of the method.

6.41.9.2.2 The burrs and warps shall be removed by grinding. For parts to be painted or metallized, the sharp edges shall also be rounded to a radius of 1.5 mm. In order to obtain a compliant coating adhesion, the flame cut edges of the parts to be painted or metallized shall be grinded or treated so as to reduce the hardness of the surface that has been hardened by the heat of the cut.

6.41.9.2.3 The marking of the heat number on the parts cut from plates shall be carried out in the presence of the Engineer.

6.41.9.3 DRILLING

6.41.9.3.1 Drilling with a blowtorch is prohibited.

6.41.9.3.2 The holes punched to the final diameter are allowed only for plates up to 16 mm thick where the steel has nominal yield strength of 350 MPa or less. For the main girder construction joints however, the holes in the girders and plates shall be drilled with a bit. In the case of worksite assemblies, the holes shall be drilled with a bit to the final diameter using a metal template.

6.41.9.3.3 All nicks and other warps on the periphery of the holes shall be removed in order to allow perfect contact between the parts to be assembled. The sections already assembled shall be disassembled to allow for this work.

6.41.9.3.4 All holes shall be drilled with accuracy perpendicularly to the surface. The parts will be rejected if the following requirements are not met at the factory-assembly:

6.41.9.3.4.1 before any reaming: 75% of the holes located in the same plane shall allow the free passage of a cylindrical joining pin of a diameter that is 3 mm smaller than the hole diameter; 100% of the holes located in the same plane shall allow the free passage of a cylindrical joining pin of a diameter that is 5 mm smaller than the hole diameter. The joining pin shall be inserted perpendicularly into the face of the member.

6.41.9.3.4.2 at least 85% of the holes reamed or drilled to their full size, contiguous and located in the same plane shall not be decentered by more than 1 mm relative to the holes of the adjacent parts.

6.41.9.4 WELDS

6.41.9.4.1 The welds shall comply with standard CAN/CSA W59.

6.41.9.4.2 The arc welding of the studs shall comprise an automatic device; the manual fillet weld is prohibited.

6.41.9.4.3 The electrodes shall have a basic coating or be designated hydrogen-controlled (HC).

6.41.9.4.4 The dimensions of the sides of a fillet weld indicated on the drawings shall not be reduced on the grounds that the manufacturer uses a submerged arc welding process (SAW process).

6.41.9.4.5 The welds shall be made before galvanizing or metallization.

6.41.9.4.6 Where a steel backing is used to make full penetration welds, it shall consist of the same steel grade as the base steel of the structure component. The minimum thickness of the backing shall comply with the following table:

| Welding Process | Minimum Thickness (mm) |
|---|---|
| SMAW (1) | 5 |
| FCAW (2) | 10 |
| SAW (3) | 10 |

(1) Shielded Metal Arc Welding.
(2) Flux-Cored Arc Welding.
(3) Submerged Arc Welding.

6.41.9.4.7 The backing shall be continuous over the entire length of the joint. The backing butt weld shall be full penetration and shall be the object of a radiographic or ultrasonic inspection before the welding of such backing to the structure component.

6.41.9.4.8 The worksite welds shall be made according to the shielded metal arc welding (SMAW) process.

6.41.9.4.9 The welding plates shall be heated immediately before the work is carried out so as to remove the moisture.

6.41.9.4.10 Prior to making the tack welds required for the fabrication of the main plate girders considered primary tension members or fracture-critical members as well as that of the main structural components considered fracture-critical members, the following minimum preheat temperatures shall be applied on the area to be welded in all directions over a distance of at least 75 mm from the weld:

6.41.9.4.10.1 150°C at the flanges;

6.41.9.4.10.2 100°C at the web when the stiffener has a thickness of 25 mm and more.

6.41.9.4.11 The **Contractor** may, however, rely on Article 5.4.7.1 of standard CAN/CSA W59 if it can demonstrate to the satisfaction of the Engineer that the tack welds made in a single pass are completely recast and incorporated into the final weld through the submerged arc welding process (SAW process). A micrographic report shall be submitted to the Engineer for each bead size recorded in the welding procedure. The samples shall be fabricated in the presence of a representative of the Engineer for each bead size recorded in the welding procedure and the macrographs shall be performed by a laboratory, member of the *Association des firmes de genie-conseil - Québec* (AFG). If the results are conclusive, the Engineer will issue an authorization valid for this welding procedure. The reference to Article 5.4.7.1 of the standard shall be recorded on the welding procedure data sheet.

6.41.9.4.12 Prior to making the final welds on the main plate girders considered primary tension members or fracture-critical members as well on the main structural components considered fracture-critical members, the preheat temperatures shall comply with Tables 12.3 and 12.4 of standard AASHTO/AWS D1.5 on the surfaces to be welded.

6.41.9.4.13 The welding procedure data sheets shall indicate the preheating temperature according to the thickness of the base metal and shall state that this temperature shall apply, as appropriate, to the main plate girders and the main structural components considered fracture-critical members.

6.41.9.4.14 Once the welding is completed, the adjacent steel surfaces shall be brushed in order to remove any splatters and welding spatter that have not firmly adhered to the metal.

6.41.9.5 GIRDER ASSEMBLY

6.41.9.5.1 All butt welds in the webs and flanges used to fabricate the welded profiles, WWF and WRF, and the plate girders shall be completed before proceeding with the assembly of the flange to the web.

6.41.9.5.2 The fillet welds at the flange-web junction of the main girders shall be made by submerged arc welding (SAW process) and shall be made without stop-start for each of the sections that make up the main girders. An appendage of at least 150 mm is required to initiate or complete the fillet weld.

6.41.9.6 FACTORY PRE-ASSEMBLY

6.41.9.6.1 The main girders that comprise construction joints shall be factory pre-assembled.

6.41.9.6.2 All sections that make up the girder shall be pre-assembled and adjusted in accordance with the drawings, with the web in horizontal position.

6.41.9.6.3 Each pre-assembly operation shall include at least two (2) sections of a girder. In the case of a span comprising three (3) or more sections or that is curved, the **Contractor** shall, at least fourteen (14) days prior to proceeding with such work, provide the Engineer with a detailed pre-assembly drawing, for review, explaining each step of pre-assembly. The **Contractor** shall await the written notice from the Engineer prior to proceeding with the pre-assembly.

6.41.9.6.4 At a main girder construction joint, the drilling of holes shall be carried out using one of the joint plates of the flange and web, whose holes have been drilled in advance in order to serve as template. It is also allowed to drill the joint plates as well as one of the two (2) girder sections with a numerical control drilling machine and to subsequently use these plates as template for drilling the other girder section. The sequence of drilling in the girder sections, joint plates and shims shall provide, for all pre-assembly operations, the use of a sufficient number of joining pins and bolts to maintain, at all times, the alignment of the holes.

6.41.9.6.5 The contact areas of the construction joint cover plates at the main girder flanges shall have a warping that is less than B/200, without exceeding 3 mm, B being the full width of the flange. The warping is measured perpendicularly to the axis of the girder, between the extension of a flange half-width and the end of the other flange half-width.

6.41.9.6.6 In the case of signage or lighting structures, the trusses and monotubular girders comprising construction joints with coupling flanges shall be factory pre-assembled. Identification numbers shall be engraved onto the coupling flanges before the joints are disassembled and a corrosion-resistant coating shall be applied.

6.41.9.7 FINAL INSPECTION

6.41.9.7.1 A part cannot be shipped from the factory before the manufacturer's dimensional reports, the reports of the non-destructive examinations of welds and the steel mill certificates have been submitted to the Engineer and that the latter has conducted his final inspection and given a written acceptance to the **Contractor**. The girders shall be placed in an upright position before the Engineer conducts the final inspection.

## 6.41.10 HANDLING, TRANSPORTATION AND ASSEMBLY OF A BRIDGE DECK STEEL STRUCTURE

6.41.10.1 The structure components shall be handled with care to avoid any damage or deformation. The girders shall be lifted by at least two (2) lifting points during handling and assembly operations.

6.41.10.2 The through plate girders shall be transported with the web in an upright position. In some particular cases where transportation cannot be done in an upright position, the girders shall be transported in accordance with the transport recommendations of the manufacturer of the beams. The Engineer will give the **Contractor** a written notice authorizing the latter to transport a girder when the support system installed is deemed compliant with the transport recommendations.

6.41.10.3 Unless otherwise indicated on the drawings, the assembly, the installation of the bolts and inspection of the assemblies shall be carried out in accordance with standard CAN/CSA S6.

6.41.10.4 The location and elevation of the bridge bearings shall be checked by the **Contractor**, and any anomalies detected shall be corrected. The **Contractor** shall provide the Engineer, at least fourteen (14) days prior to the installation of the girders, with a survey showing the location (longitudinally and transversely to the structure), elevation and leveling of each bridge bearing installed, as well as the corresponding values indicated on the drawings. Such survey shall be signed by an engineer member of the OIQ.

6.41.10.5 In order to avoid that the water, when it comes into contact with unpainted steel surfaces, stains the seats and adjacent surfaces of the foundation units, such units shall be adequately protected prior to the start of the structure assembly. Any stains on the girders or on the foundation units, such as oil and grease stains, shall be removed upon completion of work.

6.41.10.6 As indicated on the assembly process drawings and design notes, the first girder erected shall be retained laterally; the other girders shall be braced promptly after installation thereof.

6.41.10.7 When the deck is constructed in phases, temporary structures for each phase may be required to limit the lateral movement and rotation of the main girders caused by the slab concreting, without however restricting the vertical movement. These structures shall be detailed in the assembly drawings.

6.41.10.8 At the end of each work shift during which girders are installed, and after the girders have been inspected by an engineer member of the OIQ, the **Contractor** shall submit to the Engineer a written certificate signed by that engineer confirming that the temporary bracing and structures are installed in accordance with the assembly process drawings and design notes. This certificate shall also specify the date and time on which the inspection was conducted.

6.41.10.9 In order to maintain the adjustment of the structure components in accordance with the vertical and horizontal alignments indicated on the drawings, no construction overloads and no permanent loads other than that due to the metal structure shall be applied on the structure before the final tightening of the structural components subjected by these additional loads is completed.

6.41.10.10 The holes left by the removal of the temporary structures used to handle the girders shall be filled by A325 bolts. If the girders are painted, the bolts shall have the same coating as that of the girders and, in the other cases, the bolts shall be galvanized.

6.41.10.11 The temporary bracing and other temporary structures shall be maintained in place until the slab concrete has reached 70% of f'c checked by tests on control test specimens cured under the same conditions as the structure.

6.41.10.12 Unless otherwise indicated on the drawings, when a slab connection phase is planned to join two (2) phases that were cast previously, the drilling and bolting of the diaphragms and bracing located under the connection phase shall be carried out prior to the concreting of that phase, but after every adjacent slab phase has been concreted.

6.41.10.13 BOLTED JOINTS

6.41.10.13.1 The steel surfaces that are not galvanized and that are to come into contact with one another at the time of assembly shall be cleaned in accordance with standard SSPC-SP 6/NACE Nº 3 or standard SSPC – SP 15.

6.41.10.13.2 The galvanized steel surfaces that are to come into contact with one another at the time of assembly shall be cleaned manually with a wire brush in order to dull the finish without, however, affecting the zinc coating.

6.41.10.13.3 The bolts, nuts and washers shall be delivered, assembled, to the worksite in containers that were sealed at the manufacturer's factory. The identification of each container shall include the assembled bolt production batch number as well as the main characteristics of the bolts, nuts and washers. The sealed containers or containers that were opened on worksite shall be stored away from, notably, moisture, dust and dirt in order for the bolts, nuts and washers to be, until they are installed, maintained in the same condition as the condition they were in when delivered. After each workday, the unused bolts, nuts and washers shall be returned in their original containers.

6.41.10.13.4 Bolt installation

6.41.10.13.4.1 The holes shall be aligned using joining pins, and the parts shall be held together using a sufficient number of firmly tightened pre-assembly bolts. A maximum of 20% of the holes on a given joint may be aligned using pins. No reaming of holes is allowed on worksite.

6.41.10.13.4.2 In the case where the **Contractor** uses bolts that are tightened without control when the parts to be assembled are adjusted, such bolts shall be marked with red paint before the bolting work begins. These bolts shall be replaced with new bolts according to the terms of the bolting procedure submitted by the **Contractor**.

6.41.10.13.4.3 A girder section shall be retained by bolts and joining pins by filling at least 50% of the construction joint holes before it is detached from the lifting equipment. The bolts and nuts tightened manually and the joining pins concentrated on the edge of the assembly plates shall be evenly distributed in the joint flanges-web.

6.41.10.13.4.4 Before starting the final tightening of the construction joint bolts, the girder sections shall be adjusted according to the vertical and horizontal alignments indicated on the drawings, using a sufficient number of joining pins, while limiting the quantity to a maximum of 20% of pins in the same joint.

6.41.10.13.4.5 Whatever the assembly method used by the **Contractor**, the last step of the assembly of a joint consists in replacing the joining pins with bolts that are tightened at the final tightening. At this stage, all the other bolts of the joint shall have been previously installed and tightened at the final tightening.

6.41.10.13.4.6 In the case where the assembly of a girder sections is not done in their final location, the final tightening of all construction joint bolts shall be done before moving the girders to their final location.

6.41.10.13.5 Bolt tightening

6.41.10.13.5.1 All bolts shall be installed with a steel washer placed under the part, nut or bolt head, which is being turned during tightening. A washer shall be installed at each end of the bolts of an assembly comprising an oversized hole.

6.41.10.13.5.2 Unless otherwise indicated on the drawings, the nuts shall be installed on the less visible side of the structure.

6.41.10.13.5.3 The only tightening allowed is tightening by turn-of-the-nut. It is therefore prohibited for the **Contractor** to use a bolt tightening torque as final tightening method or as a method to check the final tightening of the bolts.

6.41.10.13.5.4 Snug tightening is defined as the tightening that makes it possible to bring the plate surfaces into perfect contact, which corresponds to an initial tension in the bolts of 15% ± 3% of the minimum value indicated in Article 10.24.6.3 of standard CAN/CSA S6.

6.41.10.13.5.5 The **Contractor** shall use one of the following methods to carry out the snug tightening of the bolts:

6.41.10.13.5.5.1 manual tightening using a spud wrench;

6.41.10.13.5.5.2 tightening with an adjustable key set so as to obtain the required initial tension in the bolt or with a maximum capacity not exceeding the tension indicated in paragraph 6.41.10.13.5.4.

6.41.10.13.5.6 After the snug tightening and before final tightening by turn-of-the-nut, all the assembly bolts and nuts shall be marked with a pencil so as to determine the degree of relative rotation of the two (2) parts. The marking of each nut shall be done vis-à-vis the edge closest to the 12 o'clock position, and the mark on the corresponding bolt shall be made on the bolt half-diameter at the same position as that on the nut.

6.41.10.13.5.7 After tightening, the threaded end of the bolts shall extend beyond the nut.

6.41.10.13.5.8 All bolting work shall be checked and monitored by an engineer of the **Contractor**, member of the OIQ. This engineer may not delegate his verification task, except in the case of factory bolting work other than construction site joints of the main girders. In the case of the bolting work of the site joints of the main girders, this engineer must be the signatory of the procedure of bolting submitted.

6.41.10.13.5.9 For all bolted assemblies, the **Contractor**'s engineer who has checked and monitored the bolt tightening work shall give the Engineer a certificate confirming that the bolt tightening has been carried out in accordance with every step of the bolting procedure submitted. The notice shall indicate the assemblies covered and the dates and times of the inspections conducted by the **Contractor**'s engineer. The notice shall be given to the Engineer within forty-eight (48) hours from the end of tightening of the bolts of the assemblies covered by the notice.

6.41.10.13.5.10 The snug tightening of the bolts of an assembly is deemed compliant when all bolts tested can be loosened with a spud wrench. If the tightening of one of the bolts tested is not compliant, all the assembly bolts shall be checked and those whose tightening is non-compliant shall be replaced with new bolts at the **Contractor**'s own expense. In case of non-compliance, the **Contractor**'s engineer who signed the bolting procedure shall, if needed, improve the bolt tightening method and, where applicable, submit to the Engineer a new bolting procedure before the **Contractor** continues the bolt installation.

6.41.10.13.5.11 The final tightening of the bolts of an assembly is deemed compliant when the relative rotation of each bolt and nut thereof is within the allowable tolerances established during the delivery control of the bolts. The bolts that do not meet these requirements shall be replaced according to a special procedure signed by the **Contractor**'s engineer who signed the bolting procedure, at the **Contractor**'s own expense.

6.41.10.13.5.12 For bolts that are not galvanized, the final tightening by turn-of-the-nut of all the bolts of an assembly shall be carried out within ten (10) days from the installation of the bolts in the assembly. After that period, rotational capacity tests shall be conducted on three (3) assembled bolts, bolt, nut and washer, for each production batch of assembled bolts collected in the joints concerned, in order to validate the compliance of the assemblies.

6.41.10.13.5.13 Any bolt that is loosened after final tightening shall be replaced with a new bolt.

6.41.10.13.6 Tightening of the main girder construction joint bolts

6.41.10.13.6.1 In addition to requirements for bolt tightening indicated in paragraph 6.41.10.13.5, the following requirements apply to the main girder construction joints:

6.41.10.13.6.1.1 Prior to the bolting, a meeting involving the representatives of the **Contractor**, notably the engineer who signed the bolting procedure and the supervisor in charge of the structure assembly, and the Engineer shall be held on site at least fourteen (14) days prior to the start of installation of the construction joint bolts. The meeting shall only take place when the bolting procedure shall have been deemed complete by the Engineer. The meeting agenda shall include the review of the bolting procedure and of the contractual requirements relating to the bolt installation as well as the delivery control of the bolts on at least one production batch of assembled bolts;

6.41.10.13.6.1.2 At the beginning of each work shift, the **Contractor** shall notify the Engineer in writing when the tightening of the bolts of a main girder construction joints is scheduled. That notice shall indicate the first joint on which it is planned to firmly tighten the bolts. The notice shall also indicate the probable time, during the work shift, when the final tightening of the bolts of a main girder construction joints shall take place;

6.41.10.13.6.1.3 In addition to the certificate of conformity issued following the final tightening of any bolted assembly, the tightening of at least 20% of the construction joints, with a minimum of two (2) joints, shall be checked jointly and at the same time by the **Contractor**'s engineer who signed the bolting procedure and by the Engineer for the three (3) main stages of the bolting procedure, that is, the snug tightening, marking and final tightening. The joints to be controlled will be selected by the Engineer. The tightening control will be carried out immediately after each of the following stage:

6.41.10.13.6.1.3.1 for snug tightening: verification of the tightening on approximately 10% of the bolts of the joint, with a minimum of six (6) bolts;

6.41.10.13.6.1.3.2 for marking: verification of the marking of all bolts and nuts before final tightening;

6.41.10.13.6.1.3.3 for final tightening: verification of the relative rotation between each bolt and nut thereof.

## 6.41.11 QUALITY CONTROL

6.41.11.1 GENERAL

6.41.11.1.1 At least fourteen (14) days prior to the start of steelwork, the **Contractor** shall submit to the Engineer, for review, the quality control program it intends to implement for the execution of the steelwork.

6.41.11.1.2 The Engineer will conduct its own quality assurance program by performing audits on the **Contractor**'s quality control program and by any other random inspection or check at the discretion of the Engineer. The **Contractor** shall provide samples of all materials required by the Engineer.

6.41.11.1.3 The **Contractor** shall implement a quality control program in accordance with the standard ISO 9001.

6.41.11.1.4 The program shall indicate all checkpoints that will be conducted during the execution of the following stages:

6.41.11.1.4.1 the reception of materials;

6.41.11.1.4.2 the shaping and assembly of the parts;

6.41.11.1.4.3 the transportation, reception and unloading at the worksite;

6.41.11.1.4.4 the installation of the finished parts.

6.41.11.1.5 The **Contractor** shall notify the Engineer at least fourteen (14) days prior to the start of fabrication of the components concerned.

6.41.11.1.6 The **Contractor** shall give the Engineer access to all parts of the work at all times and shall provide such information and assistance as may be required.

6.41.11.1.7 The inspection of work by the Engineer does not relieve the **Contractor** of its obligations to carry out the work in accordance with the requirements prescribed on the drawings and in the specifications.

6.41.11.1.8 The Engineer shall be informed of any defects found in the work. The **Contractor** shall not make any repairs before having obtained authorization from the Engineer to proceed. The **Contractor** shall submit in writing, for review by the Engineer, the methods thereby proposed to correct the defects. The corrective methods shall include, without limitation, the appropriate drawings, sketches and welding procedures.

6.41.11.1.9 Each repaired part shall be inspected by the Engineer before being shipped from the factory.

6.41.11.1.10 The **Contractor** may not ship any component from the factory before having obtained written authorization from the Engineer to proceed.

6.41.11.1.11 The **Contractor** shall comply with the bolt tightening procedure provided in Appendix 6.41-I *Requirements for Bolt Tightening* of this subsection, and after having confirmed to the Engineer that the final tightening has been completed by the **Contractor**, 10% of all bolts of a given assembly, but not less than two (2) bolts, shall be checked jointly by the **Contractor** and the Engineer with a torque wrench following the arbitration process described in standard CAN/CSA S6.

6.41.11.1.12 The **Contractor** shall move and support the parts to be inspected. In general, the inspection shall be carried out flat with a minimum vertical clearance of 1.25 m.

6.41.11.2 GALVANIZING

6.41.11.2.1 The **Contractor** shall include in its quality control program that the prescribed galvanizing rates indicated on the drawings are respected.

6.41.11.2.2 The quality control program shall provide, for all phases of the galvanizing works, the description, purpose and results to be achieved.

6.41.11.2.3 The quality control program shall indicate the corrective measures that will be implemented if the requested results are not achieved.

6.41.11.2.4 Before proceeding with the complete galvanizing of the new steel components covered by this Contract, the **Contractor** shall have three (3) control samples galvanized, following the prescriptions of the quality control program in order to demonstrate that the proposed procedure makes it possible to reach the galvanizing rates and thicknesses required by standard ASTM A123/A123M.

6.41.11.2.5 If the galvanizing of the sample components does not meet the requirements of standard ASTM A123/A123M, notably with regard to the thickness of the zinc layer deposited on the steel, the **Contractor** shall identify the cause of the failure, make the required corrections and thereafter proceed with galvanizing three (3) new samples and repeat the process until the specified galvanizing rates are achieved.

6.41.11.2.6 The quality of the galvanizing of the steel components shall at all times meet the requirements of standard ASTM A123/A123M.

6.41.11.2.7 The costs for implementing the quality control program shall be borne by the **Contractor**.

6.41.11.2.8 The application of the quality control program shall in no case affect the date of completion of the galvanizing work. The **Contractor** shall proceed with the design and galvanizing of the samples at the very beginning of this Contract so as not to delay the execution of the work.

6.41.11.3 WELDING

6.41.11.3.1 Destructive tests may be required by the Engineer to determine the tensile and bending limits of the welded assemblies.

6.41.11.3.2 Non-destructive examinations

6.41.11.3.2.1 Except for the drains, interface drains and sealing welds of the deck joint bolted assembly joints and unless otherwise indicated on the drawings, the non-destructive examinations of the welds shall be conducted by a laboratory, a member of the AFG, and certified by the CWB, in accordance with standard CSA W178.1.

6.41.11.3.2.2 Unless otherwise indicated on the drawings, the minimum non-destructive examinations to be conducted by the **Contractor** are those indicated in standard CAN/CSA S6. All the examinations indicated in the standard and those described in this paragraph shall be borne by the **Contractor**. The non-destructive examinations of welds shall be conducted as follows:

6.41.11.3.2.2.1 the visual check shall be fully (100%) carried out, before, during and after the welding, in accordance with standard CAN/CSA W59 by a certified Level 2 welding inspector in accordance with standard CAN/CSA W178.2. For the drains, interface drains and sealing welds of the deck joint bolted assembly joints, the welding inspector may be replaced by a welding supervisor certified in accordance with standard CAN/CSA W47.1;

6.41.11.3.2.2.2 the welds on a bridge's main girders, diaphragms, bracing and jacking girders shall, in addition to the visual check, undergo the following examinations:

6.41.11.3.2.2.2.1 a butt weld in a flange shall be 100% X-rayed;

6.41.11.3.2.2.2.2 a transversal or longitudinal butt weld in the web shall be 100% X-rayed;

6.41.11.3.2.2.2.3 a fillet weld between the web and the flange of each member section shall be checked by magnetic particle examinations on a distance equal to 25% of the length of the weld beads. The examination shall focus on the weld ends;

6.41.11.3.2.2.2.4 a fillet weld between the bearing stiffeners and the web and flanges of a member, including the stiffeners at the lifting points, shall be fully (100%) checked by magnetic particle examination;

6.41.11.3.2.2.2.5 a full penetration groove weld between the bearing stiffeners and a member flanges shall be fully (100%) checked by magnetic particle examinations and fully (100%) checked by ultrasounds;

6.41.11.3.2.2.2.6 a fillet weld between the transverse stiffeners and a member web shall be checked at 50% by magnetic particle examination. The examinations shall focus on the weld ends;

6.41.11.3.2.2.2.7 a fillet weld between the transversal stiffeners and a member flange shall be fully (100%) checked by magnetic particle examinations;

6.41.11.3.2.2.2.8 all welds on the bracing elements shall be checked at 25% by magnetic particle examination. The examinations shall focus on the weld ends.

6.41.11.3.2.2.3 a visual check and the following examinations shall be carried out on the welds of the steel piles:

6.41.11.3.2.2.3.1 the butt welds in a steel pile shall be checked by ultrasounds over 100% of the length thereof, on 25% of the joints. The joints shall be selected by the Engineer. When a joint does not comply, the next joint shall be checked, and so on until there are two (2) consecutive joints that comply before returning to the initial rate of check;

6.41.11.3.2.2.3.2 the groove welds and fillet welds between the tip and a steel pile shall be checked by magnetic particle examination over 100% of the length thereof, on 25% of the piles. When a weld does not comply, the next pile shall be checked, and so on until there are two (2) consecutive piles that comply before returning to the initial rate of check;

6.41.11.3.2.2.3.3 a butt weld in a caisson pile shall be checked by ultrasounds over 100% the length thereof;

6.41.11.3.2.2.3.4 all welds of Oslo shoes shall be factory made and fully (100%) checked by magnetic particle examination, twenty-four (24) hours after welding.

6.41.11.3.2.2.4 the fillet welds between the girder flanges and the bearings shall, in addition to the visual check, be fully (100%) checked by magnetic particle examination;

6.41.11.3.2.2.5 the fillet welds located at the base of the posts of the steel restraint systems shall, in addition to the visual check, be fully (100%) checked by magnetic particle examination on 10% of the posts, with a minimum of two (2) posts per bridge. The posts to check shall be selected by the Engineer;

6.41.11.3.2.2.6 the welds on a reinforcing plate or on a bracket retaining prestressing shall, in addition to the visual check, undergo the following examinations:

6.41.11.3.2.2.6.1 a butt weld shall be 100% X-rayed;

6.41.11.3.2.2.6.2 a fillet weld shall be checked by magnetic particle examination on a distance equal to 25% of the length of the weld beads.

6.41.11.3.2.2.7 the welds on a signage or lighting structure shall, in addition to the visual check, undergo the following examinations:

6.41.11.3.2.2.7.1 a butt weld in a steel part shall be 100% checked by ultrasounds or 100% X-rayed;

6.41.11.3.2.2.7.2 a full penetration weld shall be 100% checked by ultrasounds or 100% X-rayed;

6.41.11.3.2.2.7.3 a longitudinal partial penetration weld shall be checked by magnetic particle examination on a distance equal to 25% of the length of the weld beads. In the case of high masts, each section shall be checked;

6.41.11.3.2.2.7.4 a fillet weld on a steel structure shall be checked by magnetic particle examination on a distance equal to 25% of the length of the weld beads.

6.41.11.3.2.2.8 in a partial weld control, the check shall focus primarily on the weld ends and the critical points, such as a change in the geometry and material;

6.41.11.3.2.2.9 when a partial control reveals a defect requiring repair, the entire (100%) length of the weld shall be checked. The repaired portion of the weld shall be fully (100%) re-checked, using the same process as that used for checking the initial weld;

6.41.11.3.2.2.10 all tack welds shall be visually inspected;

6.41.11.3.2.2.11 all cracked welds detected visually, including tack welds, shall be validated by magnetic particle t examination, repaired and inspected again by magnetic particle examination.

6.41.11.3.2.3 The Engineer shall be notified at least twelve (12) hours before the beginning of the non-destructive examinations. These examinations, including the visual checks, shall be the object of a written and documented inspection report, prepared by the inspector or the supervisor who conducted and interpreted them. Such report shall include the x-rays and shall be submitted to the Engineer at least twenty-four (24) hours before the parts are shipped from the factory. In the case of welds made on site, a verbal notice from the welding inspector or supervisor shall immediately be given to the Engineer, attesting that the welds comply with the requirements of the Contract. A report shall subsequently be submitted to the Engineer within seven (7) days after the conduct of the non-destructive examinations.

6.41.11.3.2.4 The weld control shall be carried out before the galvanizing or metallization.

6.41.11.3.2.5 When the assembly of the girders of a steel structure is carried out at the rolling mill by means of WWF or WRF welded profiles, the non-destructive examinations of the web-flange welds shall be conducted at the steel structure manufacturer's factory. If butt welds in the flanges or in the web are made at the rolling mill, the x-rays and report of the non-destructive examinations of these welds shall be added to the inspection report described in paragraph 6.41.11.3.2.3.

6.41.11.3.2.6 When the assembly of signage or lighting structure parts is carried out, in whole or in part, in a factory other than that of the manufacturer, the non-destructive examinations of the welds shall be conducted at the factory of the manufacturer of these structures. The x-rays and report of the non-destructive examinations of these welds shall be added to the inspection report described in paragraph 6.41.11.3.2.3.

6.41.11.3.2.7 The non-destructive examinations of the welds shall be conducted by a laboratory, member of the AFG, that is certified by the CWB, in accordance with the requirements of standard CSA W178.1, which shall also interpret the results. The welding inspectors shall be qualified by the CWB in accordance with standard CAN/CSA A178.2.

6.41.11.3.2.8 The non-destructive examinations shall be recorded in a written report and shall be submitted to the Engineer at least twenty-four (24) hours before the components are shipped from the factory.

6.41.11.3.2.9 The **Owner** may, independently and at its own expense, conduct additional non-destructive examinations of welds. In the event of a welding defect, the **Contractor** shall pay the cost of all weld inspections that will be carried out before and after the welding defects are corrected.

**END OF SUBSECTION**

# APPENDIX 6.41-I

# REQUIREMENTS FOR BOLT TIGHTENING

# (5 PAGES)

## REQUIREMENTS FOR BOLT TIGHTENING

### PREPARATORY ACTIVITIES

1) The **Contractor** shall, at least fourteen (14) days prior to commencing the work on site, submit its bolting procedure to the Engineer, which shall be signed by an engineer who is a member of the *Ordre des ingénieurs du Québec* (OIQ).

2) During the work, the **Contractor**'s engineer may ask an engineer, member of the OIQ, under his responsibility to carry out on-site inspections and issue certificates of compliance for the tightening of the bolts. In the bolting procedure, this engineer shall be designated as the "representative" of the **Contractor.** The **Contractor** shall, prior to the start of the work, inform the Engineer in writing, who will be the representative of the Engineer of the **Contractor**.

3) The **Contractor**'s engineer, or its representative, both responsible for the tightening of the bolts verifications, and the **Contractor**'s foreman responsible for steelwork shall attend a meeting with the representatives of the **Owner** before the bolting work begins. The meeting shall be held at least seven (7) days prior to the bolt installation, but not before the Engineer has received the bolting procedure, thereby deemed complete. The agenda of the meeting shall, notably, include:

    - the review of the bolting procedure;
    - the calibration device that the **Contractor** intends to use;
    - the **Contractor**'s working methods and the procedure it intends to use for checking the tension in the bolts by means of the calibration device;
    - the on-site storage of the bolts;
    - the stopping points and control points specified by the Engineer;
    - the name and qualifications of the representative of the Contractor's engineer designated to validate the tightening stages.

### ON-SITE ACTIVITIES

1) The bolts, including the nuts and washers, shall be protected from dust and moisture. Only the sufficient number of bolts intended to be installed during a work shift shall be removed from the storage site. Bolts shall not be cleaned of their lubricant. The bolts that have accumulated rust or sand shall be cleaned and lubricated again before use thereof.

2) A calibration device shall be present at all times on the site of the bolting work. This device shall have been calibrated by a certified company, within twelve (12) months preceding the expected date of use thereof. The calibration device shall be used, among other things, to:
    - confirm the adequacy of the complete assembly, including the type and lubrication level of the bolts;
    - validate that the materials used to manufacture the bolts meet the standards and that the bolts are not counterfeit or have not been weakened;
    - ensure a good understanding of the bolting procedures by the Contractor's work teams;
    - validate the procedures proposed by the Contractor to carry out the snug tightening;
    - note and provide to the Engineer, with the help of a torque wrench, the mean values of torques corresponding to the turn of the nut at final tightening in accordance with Table 10.18 of standard CAN/CSA-S6-06, adding 5° of additional rotation of the nut. These values shall be provided for a minimum of three (3) bolts for each batch of bolts.

3) The only tightening method accepted for this Contract is the turn-of-the-nut method.

4) The **Contractor** shall first proceed with the snug tightening of the bolts, which is intended to bring the plate surfaces into perfect contact. For this Contract, the snug tightening shall be considered as an initial tension in the bolts of approximately 15% of the minimum value indicated in Article 10.24.6.3 of standard CAN/CSA-S6-06 (please refer to Table I below). The **Contractor** shall note that in some cases, the snug tightening may require more than one tightening cycle. The snug tightening shall move from the most rigid part of the assembly towards the free edge of the assembly plates. Unless otherwise specified by the Engineer, it is prohibited to use an air impact wrench for the snug tightening operation.

5) Once the snug tightening has been completed, the **Contractor** shall notify the Engineer thereof in writing. The assemblies affected by the snug tightening being the subject of the notice shall be clearly identified in the latter.

6) The tests conducted by means of the calibration device shall allow the confirmation that the method provided by the **Contractor** is capable of producing a tension in the bolts that is at least 5% greater than the minimum value indicated in Article 10.24.6.3 of standard CAN/CSA-S6-06 (please refer to Table I – below);

7) The snug tightening of approximately 10% of the bolts of each assembly, with a minimum of three (3) bolts for assemblies with less than ten (10) bolts and a minimum of six (6) bolts for the other assemblies, shall be checked by the **Contractor**'s engineer or his designated representative, in the presence of the Engineer. The snug tightening of a bolt is deemed compliant when the bolt can be loosened by means of a spud wrench of a length of at most 400 mm. The snug tightening of an assembly is deemed compliant when all bolts tested are equally compliant. When the snug tightening of a bolt is not compliant, the bolt shall be replaced. The snug tightening of all the other bolts of the joint shall be checked and every non-compliant bolt shall also be replaced; the compliant bolts of this joint may be loosened. The snug tightening operation shall then be redone and the checking procedure shall be followed again.

8) All bolts and nuts shall be marked in the 12 o'clock position, half-diameter of the bolt and adjoining nut, by the **Contractor**'s engineer or designated representative. When this step of the bolt tightening procedure is deemed satisfactory by the Engineer, the latter gives the **Contractor** a written notice authorizing him to proceed with final tightening of the assemblies.

9) Following the snug tightening and authorization issued in accordance with paragraph 8 above, the **Contractor** shall proceed to the final tightening of the bolts, by turn-of-the-nut or bolt head when the bolt is equipped with washers, according Table 10.18 of standard CAN/CSA-S6-06, that is, one third (1/3) turn for bolts of a length equal to or less than four (4) diameters and one half (1/2) turn for bolts of a length greater than four (4) diameters, but less than 200 mm. The final tightening shall progress systematically from the most rigid part of the assembly towards the free edge of the plates.

10) Once the final tightening of an assembly is completed and at the end of each work shift, the **Contractor** shall, in the presence of the Engineer and using a torque wrench, check 10% of the bolts of each assembly, but not less than two (2) bolts per assembly. If no nuts or bolt heads rotate when the torque is applied, the tightening is compliant. If, on the contrary, the torque makes the nut or bolt head, of even a single bolt being in the course of being checked, turn, the tightening is not compliant. In such a case, all the assembly bolts shall be checked, tightened and checked again.

11) When the final tightening is completed on a whole assembly, the **Contractor**'s engineer or his representative shall give the **Owner** a certificate confirming the compliance of each assembly. That notice shall indicate that the bolt tightening was carried out in compliance with each step of the bolting procedure submitted by the **Contractor**, shall identify the targeted assembly and specify the dates and times of the inspections conducted by the engineer who signed the certificate.

12) The checking of the snug tightening, the checking of the marking the bolts and nuts, the checking of the final tightening as well as the preparation and signature of the certificate shall be done by the engineer who signed the bolting procedure or his representative. In addition, a certificate, signed by the engineer who signed the bolting procedure, certifying that all bolt tightening work has been performed in accordance with the **Contractor**'s procedures**,** shall be submitted to the Engineer at the end of the work.

Table I - Snug tightening and final turn-of-nut tightening

| Bolt (type and dia.) | | Nominal dia. | Area | Minimum final turn-of-nut tightening (kN)* | | | | Snug tightening (kN) 15% of the min. final turn-of-nut tightening | |
|---|---|---|---|---|---|---|---|---|---|
| Metric | Imperial | mm (in.) | ($mm^2$) | A325 | A325M | A490 | A490M | A325 or A325M | A490 or A490M |
| | 1/2" | 12.70 mm (0.5") | 127 | 53 | ... | 67 | ... | 8 | 10 |
| | 5/8" | 15.88 mm (0.625") | 198 | 85 | ... | 107 | ... | 13 | 16 |
| M16 | ... | 16 mm | 201 | ... | 91 | ... | 114 | 14 | 17 |
| | 3/4" | 19.05 mm (0.75") | 285 | 125 | ... | 157 | ... | 19 | 24 |
| M20 | ... | 20 mm | 314 | ... | 142 | ... | 178 | 21 | 27 |
| | 7/8" | 22.23 mm (0.875") | 388 | 174 | ... | 218 | ... | 26 | 33 |
| M22 | ... | 22 mm | 380 | ... | 176 | ... | 220 | 26 | 33 |
| M24 | ... | 24 mm | 452 | ... | 205 | ... | 257 | 31 | 39 |
| | 1" | 25.40 mm (1") | 507 | 227 | ... | 285 | ... | 34 | 43 |
| M27 | ... | 27 mm | 573 | ... | 267 | ... | 334 | 40 | 50 |
| | 1-1/8" | 28,6 mm (1.125") | 641 | 249 | ... | 356 | ... | 37 | 53 |
| M30 | ... | 30 mm | 707 | ... | 326 | ... | 408 | 49 | 61 |
| | 1-1/4" | 31.75 mm (1.25") | 792 | 316 | ... | 454 | ... | 47 | 68 |
| | 1-3/8" | 34.93 mm (1.375") | 958 | 378 | ... | 538 | ... | 57 | 81 |
| M36 | ... | 36 mm | 1018 | ... | 475 | ... | 595 | 71 | 89 |
| | 1-1/2" | 38.1 mm (1.5") | 1140 | 458 | ... | 658 | ... | 69 | 99 |

*70% of the minimum tensile strength specified in the ASTM Standard (see S6-06 article 10.24.6.3)

# APPENDIX 6.41-II

# REQUIREMENTS FOR THE TENSIONING OF HIGH-STRENGTH STEEL BARS

# (1 PAGE)

# REQUIREMENTS FOR THE TENSIONING OF HIGH-STRENGTH STEEL BARS

## SCOPE OF APPENDIX 6-41-II

This appendix describes the requirements relating to the tensioning of high-strength steel bars with a calibrated tension control wrench.

## CALCULATION OF THE TIGHTENING TORQUE

The **Contractor**'s engineer shall convert its tensioning levels into torsion torque and shall further calculate the theoretical movements and rotations of the nuts that correspond to these levels. The tensioning procedure to be submitted to the Engineer by the **Contractor** shall therefore include the load bearings and the torsion torques, angular rotations of the nuts and elongations of the bars.

## CALIBRATION OF THE TENSION CONTROL WRENCH

The wrenches for the tensioning of the high-strength steel bars shall be accurately calibrated, prior to their use, to correlate the torque of the wrench to the tension in the high strength steel bar. At least fourteen (14) days prior to the start of the tensioning work, the **Contractor** shall submit to the Engineer, for review, a calibration procedure.

## SPECIAL PROVISIONS

The angular position of the coupler and the position of the high-strength steel bars relative to the couplers shall be measured before and after tensioning. The rotation at the coupler shall be canceled during all phases of tensioning. The nuts shall be lubricated with a product proposed by the **Contractor**'s engineer to reduce friction between the nut and the anchor plates.