

SECTION 905

CONCRETE REINFORCEMENT

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905.01 SCOPE

The scope of this section is to cover the supply, material, fabrication and placement of all reinforcing steel in concrete structures.

905.02 BLACK STEEL REINFORCEMENT

905.02.01 Material

Black reinforcing steel is any grade or size of deformed steel reinforcing bars which do not have a form of corrosion protection applied to the bars.

The Contractor shall supply all the reinforcing steel to be incorporated in the work.

All reinforcing steel supplied shall be new and previously unused billet deformed bars having a yield point of 400 MPa (400W), unless otherwise specified, and shall conform to CSA A23.1 "Concrete Materials and Methods of Concrete Construction" and CSA G30.18 type W "Carbon Steel Bars for Concrete Reinforcement." Steel spacers for spiral reinforcement shall be according to CSA G40.20/G40.21, Grade 350 G.

Where the Contractor utilizes concrete blocks to support the reinforcing steel, the quality of the concrete blocks shall conform to Section 904 and have properties similar to that being used in the concrete member. When requested, the Contractor shall supply test results to verify this.

When concrete chairs are not used, reinforcing supports for black reinforcing steel shall be plastic coated or stainless steel chairs or beam bolsters. Equivalent types of reinforcing steel supports may be accepted by the Owner's Representative. All reinforcing accessories, such as chairs, shall be corrosion resistant within 25mm of all exposed surfaces.

Chairs positioned on Styrofoam, evafoam, or other deformable surface shall be fitted with a baseplate or other means to prevent sinking into or damage to the deformable surface.

Reinforcing steel shall be free of excessive rust and any reinforcing steel reduced in cross section area due to rust shall be rejected.

905.02.02 Fabrication, Transportation, and Storage of Black Steel Reinforcement

All properties including laps, splices, hooks and bends in reinforcement, etc. shall be as per the most recent version of CSA S6 "Canadian Highway Bridge Design Code" and any addenda.

The Contractor shall submit 1 hardcopy and 1 electronic copy of a detailed reinforcing steel bar schedule to the Owner's Representative. The schedule shall show all

dimensions and bending diagrams for all the reinforcing steel in accordance with ACI 315R "Guide to Presenting Reinforcing Steel Design Details."

The Contractor retains responsibility for correctly detailing reinforcement but the schedule must be reviewed for conformity with the design by the Owner's Representative. Fabrication of reinforcing steel should not proceed until approval of the schedule has been obtained.

The Contractor shall transport the reinforcing steel to the site and shall store it on racks or platforms with adequate identification.

All dirt, grease or other foreign materials shall be removed from the steel prior to the placement.

905.02.03 Placing of Black Steel Reinforcement

Field bending shall not be carried out unless authorized by the Owner's Representative and heat shall not be used for this purpose. Any bends developing cracks or splits shall be rejected.

No welding shall be carried out unless specifically authorized by the Owner's Representative and if authorized, it shall be carried out in accordance with CSA W186 "Welding of Reinforcing Bars in Reinforced Concrete Construction."

Substitutions of different size bars must have the approval of the Engineer of Record. Splicing at locations other than those specified on the drawings must be reviewed by the Engineer of Record. All Contractor's requests for splices other than those detailed on the contract drawings will be at the Contractors' expense.

Reinforcing steel shall be supported and firmly held in the required positions at all times.

Bars shall be tied at all intersections except when the bar spacing is less than 250 mm in each direction, alternate intersections shall be tied. Specified distances from forms shall be maintained by supports, spacers, or other proposed means that have been reviewed and accepted by the Owner's Representative.

If reinforcement is in position for a considerable time prior to concrete being placed, then the reinforcing steel shall be re-inspected and, where necessary, cleaned to the satisfaction of the Owner's Representative prior to placement of concrete at no extra cost.

Bursting and spalling reinforcement shall be placed at nominal cover.

All reinforcement to be placed at nominal cover as per CSA S6 unless otherwise stated on the contract drawings.

905.03 GALVANIZED STEEL REINFORCEMENT

905.03.01 Material

The Contractor shall supply all reinforcing steel to be incorporated in the work.

Contractor shall provide the Owner's Representative with a certified copy of the mill test report(s) of reinforcing steel, showing physical and chemical analysis, a minimum of 4 weeks prior to beginning reinforcing work.

Upon request the Contractor shall inform the Owner's Representative of the proposed source of material to be supplied.

All rebar supports, bolts, chairs, and rods shall be non-metallic (fiberglass, plastic, etc). Concrete chairs shall not be used to support galvanized steel reinforcing bars.

Galvanized steel supports for rebar may be utilized provided that they meet the material requirements specified in this section and achieve the clear covers identified in the project documents.

All formwork supports, bars, rods, chairs, etc., shall be non-metallic (fiberglass, plastic, or accepted equal) with the exception that for buried, non-exposed surfaces, and for all substructure concrete surfaces on bridge structures, formwork ties, bolts, and rods may be fabricated of galvanized steel meeting the material requirements specified in this section. If galvanized steel supports are utilized, there shall be no metal within 25 mm of the concrete surface after form removal. The 25 mm cover shall be provided by means of plastic cones adjacent to the exposed concrete surface. In no case will the cutting back of metal ties or tie wire be permitted after the concrete has cured. In no case will the use of tubing be permitted to allow the recovery of ties. Cavities left as a result of ties shall be filled with a cement mortar and the surface left sound, smooth, even and uniform in color. These requirements apply to both cast in place and precast components.

After stripping of forms, fiberglass ties shall be cut off/broken off and grinded flush with the concrete surface. Shims or another method shall be used around the tie to protect the finished surface from damage.

Chairs positioned on Styrofoam, evafoam, or other deformable surface shall be fitted with a baseplate or other means to prevent sinking into or damage to the deformable surface.

Cold-drawn annealed steel wire ties shall be to ASTM A1064/A1064M "Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete." All tie-wires used for the installation of galvanized reinforcing bars shall be galvanized, covered with powdered epoxy resin or acceptable alternative, or be composed of a non-metallic material accepted by the Owner's Representative.

All reinforcing steel shall be deformed and shall conform to CSA G30.18 and CSA A23.1/A23.2, Grade 400W unless otherwise specified.

All galvanized reinforcing steel used shall be hot dipped galvanized in accordance with CSA G164 "Hot Dip Galvanizing of Irregularly Shaped Articles." Galvanized Reinforcing Steel shall conform to ASTM A143/A143M "Standard Practice for Safeguarding Against Embrittlement of Hot Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement" and ASTM A767/A767M "Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement." Test results for embrittlement shall be provided in advance of placement.

Galvanized reinforcement shall have a minimum zinc coating 610 g/m².

All galvanized reinforcing steel shall be protected with chromate treatment to prevent reaction with Portland cement paste as per the following:

1. If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.
2. Temperature of solution shall be equal to or greater than 32 degrees Celsius and galvanized steels shall be immersed for minimum 20 seconds.
3. If galvanized steels are at ambient temperature, add sulphuric acid as a bonding agent at concentration of 0.5% to 1%. In this case, no restriction applies to the temperature of solution.
4. Chromate solution sold for this purpose may replace the solution described above, provided it is of equivalent effectiveness. Information on this chromate product shall be provided to the Owner's Representative in advance of the galvanizing process.

905.03.02 Fabrication, Transportation, and Storage of Galvanized Steel Reinforcement

All properties including laps, splices, hooks and bends in reinforcement, etc. shall be as per CSA S6 "Canadian Highway Bridge Design Code" and the Reinforcing Steel Institute of Canada Manual of Standard Practice. Any bends developing cracks or splits shall be rejected.

The Contractor shall submit 1 hardcopy and 1 electronic copy of a detailed reinforcing steel bar schedule to the Owner's Representative. The schedule shall show all dimensions and bending diagrams for all the reinforcing steel in accordance with ACI 315R "Guide to Presenting Reinforcing Steel Design Details."

The Contractor retains responsibility for correctly detailing reinforcement but the schedule must be reviewed for conformity with the design. Fabrication of reinforcing steel should not proceed until review of the schedule by the Owner's Representative has been obtained.

Contractor shall deliver, store and handle materials in accordance with manufacturer's written instructions.

Prior to delivery to site, the Contractor shall store materials off ground and in accordance with manufacturer's recommendations in a clean, dry, well-ventilated area.

The Contractor shall deliver materials to site in original factory packaging, labelled with manufacturer's name and address. The Contractor shall transport the reinforcing steel to the site and store it on racks or platforms with adequate identification.

All dirt, grease or other foreign materials shall be removed from the steel prior to the placement.

905.03.03 Placing of Galvanized Steel Reinforcement

Field bending shall not be carried out unless authorized by the Owner's Representative and heat shall not be used for this purpose. Any bends developing cracks or splits shall be rejected.

No welding shall be carried out unless specifically authorized by the Owner's Representative and if authorized, it shall be carried out in accordance with CSA W186.

Welded galvanized reinforcing steel shall have two coats of zinc rich paint applied to the areas with removed or damaged galvanizing.

If galvanized steel is to be placed in contact with stainless or black reinforcing steel, direct contact between the steels shall be prevented by non-biodegradable tape or another means. Damaged galvanizing shall be repaired by the Contractor as described below.

Damaged galvanized coatings shall be repaired using a zinc rich paint as detailed in ASTM A780M "Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings." Excessively damaged or defective components, as determined by the Owner's Representative, shall be replaced with new at the Contractor's expense.

Substitutions of different size bars must have the approval of the Engineer of Record. Splicing at locations other than those specified on the drawings must be accepted by the Engineer of Record. All Contractor's requests for splices other than those detailed on the contract drawings will be at the Contractors' expense.

Reinforcing steel shall be supported and firmly held in the required positions at all times.

Bars shall be tied at all intersections except when the bar spacing is less than 250 mm in each direction, alternate intersections shall be tied. Specified distances from forms shall be maintained by supports, spacers, or other proposed means that have been reviewed and accepted by the Owner's Representative.

If reinforcement is in position for a considerable time prior to concrete being placed, then the reinforcing steel shall be re-inspected and, where necessary, cleaned and repaired using zinc rich paint. Cleaning processes shall not damage the hot dipped galvanic coating.

Bursting and spalling reinforcement shall be placed at nominal cover.

All reinforcement to be placed at nominal cover as per of CSA S6 unless otherwise stated on the contract drawings.

905.04 STAINLESS STEEL REINFORCEMENT

905.04.01 Material

The Contractor shall supply all the reinforcing steel to be incorporated in the work.

Stainless reinforcing steel bars shall be manufactured and tested in accordance with the applicable standard(s).

The yield strength shall be determined using the offset method (0.2 %).

Supports used to maintain the specified reinforcing steel concrete cover or for separation between layers of bars shall be of adequate strength, shape and dimension, and accepted for use by the Owner's Representative.

All rebar supports, bolts, chairs, and rods shall be non-metallic (fiberglass, plastic, etc). Concrete chairs shall not be used to support stainless steel reinforcing bars.

Stainless steel supports for rebar may be utilized provided that they meet the material requirements specified in this section and achieve the clear covers identified in the project documents.

All formwork supports, bars, rods, chairs, etc., shall be non-metallic (fiberglass, plastic, or accepted equal) with the exception that for buried non-exposed surfaces and for all substructure concrete surfaces on bridge structures, formwork ties, tie wire, bolts and rods may be fabricated of stainless steel meeting the material requirements specified in this section. If stainless steel supports are utilized there shall be no metal within 25 mm of the concrete surface after form removal. The 25mm cover shall be provided by means of plastic cones adjacent to the exposed concrete surface. In no case will the cutting back of metal ties or tie wire be permitted after the concrete has cured. In no case will the use of tubing be permitted to allow the recovery of ties. Cavities left as a result of ties shall be filled with a cement mortar and the surface left sound, smooth, even and uniform in color. These requirements apply to both cast in place and precast components.

After stripping of forms, fiberglass ties shall be cut off/broken off and grinded flush with the concrete surface. Shims or another method shall be used around the tie to protect the finished surface from damage.

Chairs positioned on Styrofoam, evafoam, or other deformable surface shall be fitted with a baseplate or other means to prevent sinking into or damage to the deformable surface.

When Stainless Steel Reinforcement is used, all formwork supports, bars, rods, chairs, etc., shall be non-metallic (fiberglass, plastic, or accepted equal). Chairs positioned on Styrofoam, evafoam, or other deformable surface shall be fitted with a baseplate or other means to prevent sinking into or causing damage to the deformable surface.

Tie wire used to tie stainless steel reinforcing bars to stainless steel reinforcing bars, reinforcing steel bars, and shear studs, shall be Type 316 LN or Type 316L, stainless steel wire, 1.2 or 1.6 mm in diameter.

Reinforcing stainless steel bars, splice bars, tie bars, dowel bars, hook-bolt dowels, and spirals shall be according to ASTM A276M "Standard Specification for Stainless Steel Bars and Shapes" and ASTM A955M "Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement", minimum Grade 420 (Minimum yield strength of 420 MPa). Stainless steel spacers, according to ASTM A276, shall be provided with the spirals. Nominal dimensions, unit masses, and deformation requirements for metric bar sizes shall be according to CSA G30.18.

Stainless reinforcing steel shall be of the following designation as defined by the Unified Numbering System (UNS):

- S31803 (2205 Duplex)

Stainless reinforcing steel shall be shot blasted and pickled at the production mill to remove all mill scale and surface oxidation.

Unless otherwise specified, only one type of stainless reinforcing steel shall be supplied for use throughout the project.

905.04.01.01.01 Mill Tests and Material Testing Requirements

All stainless steel supplied to the project shall be accompanied by mill test reports. Mill test reports for each heat number shall be legible and provided in English to the Owner's Representative a minimum of 2 weeks prior to shipping to site. The Contractor shall maintain a tracking system and records for all reinforcing steel fabricated and installed and provide this information to the Owner's Representative upon request. Mill test reports at a minimum shall include: heat number, date, and location of production, compliance with production standards, chemical analysis, mechanical properties, and pickling process details for stainless reinforcing steel. Mill test reports shall be authenticated by the manufacturer.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 "General Requirements for the Competence of Testing and Calibration Laboratories" by an organization accredited by the Standards Council of Canada for the tests required.

Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

Stainless steel utilized solely as formwork or rebar supports shall be provided with a mill test report from the manufacturer; however, verification by a Canadian laboratory is not required.

905.04.02 Fabrication, Transportation, and Storage of Stainless Steel Reinforcement

All properties including laps, splices, hooks and bends in reinforcement, etc. shall be as per CSA S6 and any addenda.

The Contractor shall submit 1 hardcopy and 1 electronic copy of a detailed reinforcing steel bar schedule to the Owner's Representative. The schedule shall show all dimensions and bending diagrams for all the reinforcing steel in accordance with ACI 315R.

The Contractor retains responsibility for correctly detailing reinforcement but the schedule must be reviewed for conformity with the design. Fabrication of reinforcing steel should not proceed until review of the schedule has been obtained.

Fabrication facilities shall follow the guidelines as set out in ANSI/CRSI-IPG4.1 "Standard Practice for Stainless Steel Reinforcing Bar Fabrication Facilities"

All bars requiring bends shall be cold bent at the fabrication facility. Heating of bars to facilitate bending will not be permitted. Any bends developing cracks or splits shall be rejected.

Bars shall be cut by shearing or with fluid cooled saws. Torch cutting will not be permitted. Bars showing evidence of torch cutting will be rejected.

Unless otherwise specified, all hooks and bends shall be fabricated using the pin diameters and dimensions recommended in the Reinforcing Steel Institute of Canada (RSIC) Manual of Standard Practice. Bars shall conform accurately to the dimensions shown on the Drawings, and be within the fabricating tolerances detailed in the RSIC Manual of Standard Practice.

Fabrication of stainless reinforcing steel shall be carried out such that bar surfaces are not contaminated with deposits of iron or other non-stainless steels; or suffer damage due to straightening or bending. Stainless reinforcing steel fabrication facilities shall be exclusive to the fabrication of stainless reinforcing bars or in a facility that provides a permanent fixed physical barrier which fully isolates fabrication processes. Fabrication shall occur only on equipment dedicated solely to fabrication of stainless reinforcing steel bars. All machinery points that come into contact with stainless reinforcing steel bars shall consist of hardened steel (minimum of 35 Rockwell), stainless steel, or nylon. All racking shall be protected with hardened steel (minimum of 35 Rockwell), stainless steel, nylon or wood.

Reinforcing steel bars shall be fabricated without laminations or burrs.

Reinforcing steel shall be covered and protected at all times during transportation.

Lifting of stainless steel reinforcing shall be completed with nylon strapping dedicated to stainless steel reinforcing bars. Fork trucks used in the handling of coil or straight stainless reinforcing steel shall have their forks covered with hardened steel (minimum of 35 Rockwell), stainless steel, or nylon. Stainless steel reinforcing bar bundles shall be tied with plastic strapping or stainless steel tie wire and not with carbon steel or epoxy coated carbon steel strapping.

Polyethylene wrap shall be used to fully cover all stainless reinforcing steel bars and bundles for shipping. Stainless steel reinforcing bars shall also be tarped at all times during shipping with tarps dedicated for stainless steel reinforcing bars.

Reinforcing steel of differing material types shall be stored separately. Bar tags identifying the material type shall be clearly visible and shall be maintained in-place until installation of the material.

The Contractor shall store all reinforcing steel on platforms, skids, or other suitable means of support able to keep the material above the ground surface while protecting it from mechanical damage or deterioration.

905.04.03 Placing of Stainless Steel Reinforcement

Field bending shall not be carried out unless authorized by the Owner's Representative and heat shall not be used for this purpose. Any bends developing cracks or splits shall be rejected.

No welding shall be carried out unless specifically authorized by the Owner's Representative and if authorized, it shall be carried out in accordance with CSA Standard W186.

If stainless steel is to be placed in contact with galvanized or black reinforcing steel, direct contact between the steels shall be prevented by non-biodegradable, non-electrically conductive tape or another means.

Stainless bars with surface defects due to installation shall be assessed and repaired as per Section 905.04.04.

Welding of non-stainless steel shall not be permitted in the vicinity of stainless steel. If contamination of the stainless steel occurs as described in Section 905.04.04, the steel shall be repaired or replaced at the contractor's expense.

Substitutions of different size bars must have the approval of the Engineer of Record. Splicing at locations other than those specified on the drawings must be accepted by the Engineer of Record. All Contractor's requests for splices other than those detailed on the contract drawings will be at the Contractors' expense.

Reinforcing steel shall be supported and firmly held in the required positions at all times.

Reinforcing steel containing any loose rust, scale, dirt, paint, oil, concrete, concrete paste or other foreign materials shall be cleaned or replaced to the full satisfaction of the Owner's Representative prior to being incorporated into the Work.

Bars shall be tied at all intersections except when the bar spacing is less than 250 mm in each direction, alternate intersections shall be tied. Specified distances from forms shall be maintained by supports, spacers, or other proposed means that have been reviewed and accepted by the Owner's Representative.

If reinforcement is in position for a considerable time prior to concrete being placed, then the reinforcing steel shall be re-inspected and, where necessary, cleaned prior to placement of concrete.

Bursting and spalling reinforcement shall be placed at nominal cover.

All reinforcement to be placed at nominal cover as per CSA-S6 unless otherwise stated on the contract drawings.

905.04.04 Repair of Stainless Steel Reinforcement

Individual stainless steel bars exhibiting any of the following defects prior to concrete pouring shall be repaired or replaced by the Contractor at their expense:

- Any location of contamination from grinding or cutting slag;
- Any location of iron contamination greater than 100 mm in length;
- More than 10 discrete points(1) of iron contamination on bar deformations within any 1000 mm of bar length;
- More than 20 discrete points(1) of iron contamination on bar deformations per bar; or
- More than 5 discrete points(1) of iron contamination that are not located on bar deformations per bar.

Notes:

- (1) A discrete point is defined as an area of contamination less than or equal to 5 mm². If any area of contamination is larger than 5 mm², the area shall be divided by 5 to determine the number of discrete points.

Bars exhibiting excessive staining, as determined by the Owner's Representative, shall have the contaminants identified by energy dispersive x-ray analysis (EDXA) or be removed from service. Costs associated with contaminant identification or the removal of bars from service shall be carried out by the Contractor at their expense.

Removal of non-stainless steel particles from the bar shall be completed using a wire brush with stainless steel bristles.

If the wire brush proposal detailed above is not effective or not applicable to the repair needed, the Contractor may propose an alternative method of repair. Proposals for the repair of stainless reinforcing steel bars shall be reviewed by the Owner's Representative prior to implementation. If repair cannot be completed to the satisfaction of the Owner's Representative, the bar shall be replaced at the Contractor's expense.

Stainless reinforcing steel bars exhibiting signs of mechanical damage shall be replaced at the Contractor's expense.

905.05 MEASUREMENT FOR PAYMENT

905.05.01 Measurement For Payment For Reinforcing Steel Used In Those Contract Items Where The Unit Of Measurement Is Stated In Tonnes.

For those contract items where the unit of measurement for “Black Steel Reinforcement”, “Galvanized Steel Reinforcement”, and “Stainless Steel Reinforcement” on the Unit Price Table is stated in tonnes, then the total length of reinforcing steel used in the construction will be measured for payment. The payment quantity shall be determined by multiplying the lengths of reinforcing bars actually placed in the structure by its weight per metre according to the following table:

BAR DESIGNATION	MASS WEIGHT KG/M
10M	0.785
15M	1.570
20M	2.355
25M	3.925
30M	5.495
35M	7.850

The total value will be converted to tonnes, calculated to two decimal places. Where substitution has occurred, the theoretical value will apply. Only that steel required by the contract drawings will be measured.

No allowance will be made for clips, wire, chairs, or other material used to fasten reinforcing steel in place. Measurement for payment purposes shall not be made for diaphragm inserts.

That reinforcing steel placed in concrete girders, double tees, or any other precast component shall not be included in the measurement for payment. Payment for this steel will be included with supply of precast component or concrete girder.

Measurement for payment purposes will not be made for lap lengths if the bars are less than 11 metres long unless the lap is specifically indicated on the contract drawings.

905.05.02 Measurement For Payment For Reinforcing Steel Used In Conjunction With Those Contract Items Where Reinforcement Is Considered Incidental To The Work.

Where reinforcement is considered incidental to the work, no reinforcing steel will be measured for payment purposes. Items where reinforcing steel is considered incidental are catch basins, manholes, toe walls, head walls for culverts not greater than 1,500 mm diameter, footings for stairs, encasements for pipes not greater than 600 mm diameter, collars for pipes or other items as defined in the contract.

905.06 BASIS OF PAYMENT

"Black Steel Reinforcement", "Galvanized Steel Reinforcement", and "Stainless Steel Reinforcement" shall be priced separately under the item "Supply and Place Reinforcing Steel Except in Prestressed Girders" of the Unit Price Table.

Payment at the contract price for "Black Steel Reinforcement," "Galvanized Steel Reinforcement," and "Stainless Steel Reinforcement," in the Unit Price Table shall be full compensation for providing all test certificates, supplying all materials at the work site, for storing, protecting and cleaning the reinforcing steel as required, for bending, cutting and welding the reinforcing steel, for placing the reinforcing steel in the work; for supporting the reinforcing steel during the placing, compacting and setting of concrete, and for such other work as may be required to complete the supply and placing of reinforcing steel as outlined in this section.

The supply of reinforcing steel at the work site properly stored and protected and in proper condition for incorporation into the work shall be deemed for progress payment purposes to constitute 75% of the work to be carried out under the Item "Supply And Place Reinforcing Steel Except In Prestressed Girders".