CONSTRUCTION SPECIFICATION FOR METAL RAILINGS FOR STRUCTURES

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908.01 SCOPE

This specification covers the requirements for metal railings and inspector guard for structures including posts and anchorage assembly.

908.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 906 Structural Steel for Bridges
OPSS 911 Coating Structural Steel Systems

Ontario Ministry of Transportation Publications

Designated Source for Materials (DSM)

CSA Standards

G40.20/G40.21-04 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
O80 Series-08 (R2012)	Wood Preservation
W47.1-19	Certification of Companies for Fusion Welding of Steel
W47.2-11 (R2020)	Certification of Companies for Fusion Welding of Aluminum
W59-18	Welded Steel Construction
W59.2-18	Welded Aluminum Construction
S6:19	Canadian Highway Bridge Design Code

ASTM International

A27/A27M-20	Standard Specification for Steel Castings, Carbon, for General Application
A108-18	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
A123/A123M-17	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-16a	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307-14	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A500/A500M-20	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A563-15	Standard Specification for Carbon and Alloy Steel Nuts
A780/A780M-09(2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B108/B108M-19	Standard Specification for Aluminum-Alloy Pavement Mold Castings
B117-19	Standard Practice for Operating Salt Spray (Fog) Apparatus
B209M-14	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B221M-13	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
B695-04(2016)	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
D4541-17	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
F593-17	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F594-09(2020)	Standard Specification for Stainless Steel Nuts
F844-19	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
F880M-16	Standard Specification for Stainless Steel Socket Set Screws (Metric)
F3125/F3125M-19	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

SSPC, American Welding Society (AWS) and NACE Joint Publications

SSPC-CS 23.00 / AWS C2.23M / NACE No.12-2016	Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for Corrosion Protection of Steel.

908.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchorage Assembly means an assembly of metal plates, rods/bolts, nuts and washers installed with posts to anchor metal railing/inspector guard system into concrete.

Barrier Wall Railing means a metal railing that is anchored to the top of a concrete barrier wall and is part of a barrier system that has undergone the barrier appraisal requirements of CSA-S6.

Bicycle Railing means an all-metal barrier system mounted on a structure that is designed to meet the bicycle barrier requirements of CSA-S6.

Combination Railing means a metal railing that is fastened to concrete barrier designed to meet the combination barrier requirements of CSA-S6.

Inspector Guard means metal safety guard anchored to the concrete abutment seat, walls or RSS coping to protect the inspector from a fall during inspection and has been designed to meet the Ontario Building Code requirements.

Metal Railing is a generic term used for metal part of parapet wall, barrier wall, pedestrian, bicycle, or combination railing.

Parapet Wall Railing means a metal railing that is fastened to the top of a concrete parapet wall and is part of a traffic barrier system that has undergone the barrier appraisal requirements of CSA-S6.

Pedestrian Railing means an all-metal railing system mounted on a structure that is designed to meet the pedestrian barrier requirements of CSA-S6.

908.04 DESIGN AND SUBMISSION REQUIREMENTS

908.04.01 Submission Requirements

908.04.01.01 General

Three sets of Working Drawings shall be submitted to the Contract Administrator, prior to commencement of fabrication of the metal railing and/or inspector guard, for information purposes only. Prior to a submission, an Engineer’s seal and signature shall be affixed on the Working Drawings verifying that the drawings are as specified in the Contract Documents.

When multi-discipline engineering work is depicted on the same Working Drawing and a single Engineer is unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional Engineers as necessary.

The manufacturer shall not commence fabrication of the metal railing or the inspector guard until receiving a sealed and signed copy of the Working Drawings. A copy of these drawings shall be retained at the manufacturing plant during the fabrication.

A sealed and signed copy of the metal railing and/or inspector guard Working Drawings shall be at the site prior to and during installation of the metal railing and/or inspector guard.

908.04.01.02 Inspection after the Fabrication of Metal Railing and Inspector Guard

A Manufacturer's Certificate of Conformance and a Request to Proceed for each individual shipment shall be submitted to the Contract Administrator upon completion of fabrication of the metal railing and inspector guard and prior to shipping from the plant.

The metal railing and inspector guard for each individual shipment shall not be delivered from the plant until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

908.04.01.03 Mill Test Certificates

Mill test certificates shall be submitted according to OPSS 906.

908.04.01.04 Test Reports for Fasteners and Anchorages

Test reports demonstrating that the bolts, anchorages, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as specified in the Contract Documents shall be submitted to the Contract Administrator. Verification of the acceptability of assemblage of zinc-coated bolts, anchors, nuts, and washers delivered to the job site shall be submitted to the Contract Administrator.

For bolts, anchors, nuts, and washers supplied from a manufacturer outside of Canada or the United States of America, the above information shall be verified by testing at a Canadian laboratory according to the Mill Test Certificates clause of OPSS 906.

908.05 MATERIALS

908.05.01 Metal Railings

908.05.01.01 Steel Railing and Steel Posts

Steel shall be according to CSA G40.20/G40.21.

Rails and posts shall be Grade 350W or 350WT as specified in the Contract Documents.

Steel plate shall be Grade 300W or 350W as specified in the Contract Documents.

Galvanized bolts and nuts shall be according to ASTM A307 or ASTM F3125/F3125M, Grade A325 as specified in the Contract Documents.

Studs shall be according to ASTM A108. Lock nuts shall be according to ASTM A563. Washers shall be according to ASTM F844.

Cast steel posts shall be according to ASTM A27, Grade 65-35.

Paint shall be as specified in the Contract Documents.

908.05.01.02 Aluminum Railing and Aluminum Posts

Extruded aluminum tubing shall be 6061-T6 or 6351-T6 alloy according to ASTM B221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B209M.

Cast Posts shall be A444.0-T4 heat-treated according to ASTM B108. Extruded posts shall be 6061-T6 or 6351-T6.

908.05.01.03 Stainless Steel Fasteners

Bolts shall be according to ASTM F593, Type 304 or 316 stainless steel with matching nuts according to ASTM F594 and matching washers. Set screws shall be according to ASTM F880M, Type 304 or 316 stainless steel.

908.05.01.04 Galvanized Hardware

L-bolt assemblies shall be according to ASTM A307 and include hex nuts, flat washers, and lock washers. The assemblies shall be galvanized according to ASTM A153/A153M.

908.05.02 Inspector Guard

Steel railing and posts shall be according to ASTM A500 Grade C, or CSA G40.20/G40.21 Grade 300W.

Steel plate shall be Grade 300W as specified in the Contract Documents.

Galvanized bolts and nuts shall be as specified in the Contract Documents.

Lock nuts shall be according to ASTM A563. Washers shall be according to ASTM F844.

Coating shall be as specified in the Contract Documents.

908.05.03 Anchorage Assembly

Anchorage assemblies shall be as specified in the Contract Documents.

The anchorage assembly shall be supplied with the bolts installed in a template.

908.05.04 Grout

Grout shall be non-staining, non-shrink cement based grout or non-staining, non-shrink epoxy based grout, and as specified in the Contract Documents.

908.05.05 Hot Dip Galvanizing

Purity of the zinc and the galvanizing bath composition for hot dip galvanizing of steel railing and Inspector Guard components shall be according to ASTM A123/A123M.

908.05.06 Zinc-Rich Touch-Up Paint

Zinc-rich touch-up paint shall be according to the ministry's DSM.

908.05.07 Thermal Sprayed Metal Coatings

Thermal sprayed metal coatings shall be according to SSPC-CS 23.00 / AWS C2.23M / NACE No.12. The metallizing wire for thermal metal spray coatings shall be an alloy consisting of 85% zinc and 15% aluminum.

908.05.08 Zinc-Tin-Copper Solder

The zinc-tin-copper solder shall be 50% zinc, 49% tin, and 1% copper used with the manufacturer's recommended flux.

908.07 CONSTRUCTION

908.07.01 Fabrication of Metal Railings and Inspector Guard

908.07.01.01 General

The railing system and inspector guard components shall be fabricated as specified in the Working Drawings. Field modification shall only be done when approved by the Contract Administrator.

The fabricator shall be certified according to CSA W47.1, Division 1 or Division 2 for steel railings or CSA W47.2, Division 1 or Division 2 for aluminum railings.

908.07.01.02 Steel Components

908.07.01.02.01 Fabrication

908.07.01.02.01.01 General

Fabrication and welding shall be according to OPSS 906 and CSA W59. All welding inspection shall be according to CSA W59.

All flame cut edges shall be as smooth and regular as those produced by edge planing and shall be free of slag.

908.07.01.02.02 Surface Preparation for Hot Dip Galvanizing

The metal railing and inspector guard components shall be cleaned according to OPSS 911 prior to galvanizing.

908.07.01.02.03 Hot Dip Galvanizing

Hot dipped galvanizing of steel railing and inspector guard components shall be according to OPSS 911.

908.07.01.02.04 Zinc and Zinc-Nickel Plating

Setscrews shall have zinc-nickel plating applied to a thickness of 10 µm. The plating shall show no red rust after 1,000-hour exposure to salt spray according to ASTM B117.

Lock nuts shall be zinc plated according to ASTM B695.

908.07.01.02.05 Paint Coating of Galvanized Surfaces

When specified, paint coating of galvanized surfaces shall be according to OPSS 911.

908.07.01.02.06 Repair of Damage to Galvanized Coating

When the galvanized surface of a steel railing or inspector guard component is damaged or uncoated, the exposed steel shall be repaired if the cumulative total of the damaged and uncoated areas does not exceed 2% of the total area of each component or 0.02 m^2, whichever is less. Where the cumulative area exceeds these amounts, the damaged coating shall be stripped and the component re-galvanized according to ASTM A123/A123M.

Damaged and uncoated areas shall be cleaned of all rust and other contaminants and repaired using one of the following methods:

a) Soldering method using zinc-tin-copper solder

The surface preparation and application of flux and zinc-tin-copper solder shall be according to ASTM A780/A780M and the manufacturer's recommendations. The finished thickness of the metal coating in the repaired area shall be a minimum of 90 µm. The repaired surface shall be ground flush with the surrounding galvanized coating.

b) Thermal Metal Spraying

The surface preparation and application of thermal spray metal coating or metallizing shall be done according to SSPC-CS 23.00/AWS C2.23M/NACE No. 12 to provide a minimum thickness of 200 µm, applied in two separate coats.

The metal coating on the repaired areas shall have a minimum adhesion of 2.8 MPa, when tested according to ASTM D4541.

c) Zinc-Rich Touch-Up Paint

This method of repair of galvanized coating is permitted when:

i. The individual damaged and uncoated area is less than 625 mm^2, and

ii. The number of repair spots does not exceed 6 per each 12 m section of galvanized rail bar or inspector guard. The number of repair spots in each galvanized rail post shall be limited to a maximum of 2.

Two coats of one of the approved zinc-rich touch-up paint shall be brush applied after the surface preparation according to ASTM A780/A780M.

908.07.01.03 Aluminum Components

908.07.01.03.01 Fabrication

908.07.01.03.01.01 General

Welding of aluminum shall be permitted only where specified in the Working Drawings.

Fabrication and welding shall be according to CSA W59.2. All welding inspection shall be according to CSA W59.2.

Aluminum railings and posts shall be thoroughly cleaned of all discolorations by approved methods and all marks and scratches shall be removed. The railings, when erected, shall have a clean degreased aluminum surface of uniform appearance and texture.

Railing components shall be joined by riveting, bolting, expanding, or welding as specified in the Working Drawings. Special aluminum alloy fasteners shall only be used with written approval from the Contract Administrator.

When tubular balusters are fastened to the horizontal rails by expanding the tubes, the holes drilled into the rail shall not be more than 1 mm greater than the nominal diameter of the baluster tube. A standard self-feeding tapered roll expander shall be used to expand the balusters to allow for a tight fit in all rails.

Sheet or plate material may be sheared, sawn, or cut with a router; however, sheet or plate materials more than 10 mm thick shall only be sawn or routed. Cut edges shall be true and smooth, free from excessive burrs and ragged edges.
Re-entrant cuts shall only be used when unavoidable and, when they are used, a fillet shall be provided by drilling prior to cutting.

Aluminum alloys shall not be flame cut.

Boltholes in 10 mm or thinner material may be drilled or punched to finished size. In material thicker than 10 mm, the holes shall be drilled to finished size or sub-punched smaller than the nominal diameter of the fastener and reamed to size.

During fit-up, holes shall not be drifted in such a manner as to distort the metal, but holes misaligned less than 2 mm may be reamed to render a reasonable fit.

The shank of bolts shall be long enough to provide full bearing in the connection and, where the shank extends beyond the surface being clamped, washers shall be used under the nuts to ensure proper clamping.

908.07.01.03.02 Contact Surfaces

Where aluminum would otherwise come in contact with other metal surfaces, the contacting surfaces shall be separated from each other by use of a synthetic rubber or neoprene gasket. The single rail and double rail galvanized steel railings mounted on aluminum casting posts on top of a barrier wall or parapet wall are exempt from these requirements.

Where aluminum would otherwise come in contact with concrete, wood, or masonry, the contact surfaces shall be separated by means of a synthetic rubber or neoprene gasket or the aluminum surface shall be given a heavy coat of alkali-resistant bituminous paint prior to installation. The paint shall be applied as it is received from the manufacturer without the addition of thinner.

908.07.02 Anchorages

908.07.02.01 General

Anchorage assemblies shall be installed as specified in the Contract Documents.

908.07.02.02 Anchorages Installed Before Concrete Placement

When specified in the Contract Documents, anchorage components shall be installed prior to placing concrete and shall be securely tied to reinforcing steel. Anchorage assemblies shall be positioned with templates and installed securely in the formwork to maintain the position of the anchors during placement of concrete.

908.07.02.03 Anchorages Installed After Concrete Placement

When specified in the Contract Documents, anchorages shall be installed after concrete placement. Holes shall be core drilled, anchoring grout placed, and anchors properly positioned at locations as specified in the Contract Documents. The placement of the anchoring agent and the anchors shall be according to the manufacturer's recommendations, except as modified in this clause. The holes shall be free of dust and debris immediately prior to placement of the anchoring agent. When the anchoring agent fails to fill the hole after insertion of the anchor, additional anchoring agent shall be immediately added to fill the hole.

When a cement based grout is used as the anchoring agent, the holes shall be pre-dampened for a period of one hour and any free water shall be removed prior to the application of the cement based grout.

When an epoxy grout is specified as the anchoring agent, the inside surface of the holes shall be roughened and dry prior to the application of the epoxy grout.

Where anchors are inserted into horizontal or inclined holes in a vertical face, the anchors shall be maintained in position during the setting of the anchoring agent. Loss of anchoring agent from the holes shall be prevented.

908.07.02.04 Anchorages Installed in Timber

Holes for bolts shall be drilled with a bit 1.5 mm larger in diameter than the bolt. The diameter of the recessed holes for the bolt heads shall be no greater than 10 mm larger than the width of the bolt head.

Where oil treatment has been used on the wooden curbing, the cut surfaces of the wood shall be given three coats of creosote oil. Each coat shall be allowed to dry before the next coat is applied.

Repairs to cuts in material treated with water-borne preservatives shall be according to CSA O80 Series.

908.07.03 Installation of Metal Railings and Inspector Guard

908.07.03.01 General

Metal railing and inspector guard shall be installed according to the Working Drawings.

Metal railing and inspector guard components shall be protected from damage and distortion during hot dip galvanizing, handling, transportation, storage, and installation.

Bedding grout shall not be used. Epoxy grout may be placed under post bases, as necessary, to fill the voids. The epoxy grout shall not have a thickness exceeding 3 mm. The surface preparation, mixing, installation, and curing time for the epoxy grout shall be according to the manufacturer's recommendations.

The work shall include installation of the anchorage assemblies installed after concrete placement or installed in wood.

908.07.03.02 Alignment

The metal railing and inspector guard shall be installed to the elevations and alignments as specified in the Contract Documents within a tolerance of $\pm$ 6 mm and with no kinks or other visible breaks in alignment throughout the length of the installation.

908.07.04 Quality Control

908.07.04.01 Inspection After Preparation of the Anchorages

A Request to Proceed shall be submitted to the Contract Administrator upon preparation of the anchorages and prior to the installation of the metal railing or inspector guard.

The installation of the metal railing or inspector guard shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

908.07.04.02 Inspection After Installation of the Metal Railing or Inspector Guard

An inspection after installation shall be performed of the metal railing and/or inspector guard to ensure all the requirements are met as specified in the Working Drawings. The alignment of the metal railing or inspector guard shall remain within the tolerance limits after installation.

908.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

908.08 QUALITY ASSURANCE

908.08.01 General

Access shall be provided to the Owner to do inspection, testing, and sampling in the fabricating shop and field if requested to confirm that the materials supplied, the fabrication, and the installation have been completed as specified in the Contract Documents and Working Drawings.

908.09 MEASUREMENT FOR PAYMENT

908.09.01 Actual Measurement

908.09.01.01 Barrier Wall Railing
Parapet Wall Railing
Pedestrian Railing
Bicycle Railing
Combination Railing
Inspector Guard

Measurement of metal railings and inspector guard shall be by length in metres from end to end of the railing/inspector guard.

908.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

908.10 BASIS OF PAYMENT

908.10.01 Barrier Wall Railing - Item
Parapet Wall Railing - Item
Pedestrian Railing - Item
Bicycle Railing - Item
Combination Railing - Item
Inspector Guard - Item

Payment at the Contract price for the above tender items shall be full compensation for labour, Equipment, and Material to do the work.