



## **CONSTRUCTION SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE**

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#### **905.01 SCOPE**

This specification covers the requirements for the placement of steel reinforcement and mechanical connections for concrete structures.

##### **905.01.01 Specification Significance and Use**

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

## **905.01.02 Appendices Significance and Use**

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

## **905.02 REFERENCES**

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

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

### **Ontario Provincial Standard Specifications, Construction**

OPSS 616 Footings and Pads for Electrical Equipment  
OPSS 909 Prestressed Concrete - Precast Members  
OPSS 910 Stressing Systems for Post-Tensioning

### **Ontario Provincial Standard Specifications, Material**

OPSS 1440 Steel Reinforcement for Concrete

### **Ontario Ministry of Transportation Publications**

Structural Manual

Laboratory Testing Manual:

LS-434 Method of Test for Mechanical Connectors Used to Splice Steel Reinforcement

### **CSA Standards**

G30.18-09 Carbon Steel Bars for Concrete Reinforcement  
S6-06 Canadian Highway Bridge Design Code  
W186-M1990 (R2012) Welding of Reinforcing Bars in Reinforced Concrete Construction

## ASTM International

A 276-10	Stainless Steel Bars and Shapes
A 421 / A 421M - 10	Uncoated Stress - Relieved Steel Wire for Prestressed Concrete
A 955 / A 955M - 12e1	Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

### 905.03 DEFINITIONS

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

**Mechanical Connection** means a joining of two reinforcing steel bars, stainless steel reinforcing bars, or post-tensioning tendons by means of a mechanical connector.

**Mechanical Connector - Post-Tensioning** means a mechanical device that is used to join post-tensioning tendons.

**Post-Tensioning** means a method of prestressing in which tendons are stressed after the concrete has reached a predetermined strength.

**Prestressing Steel** means steel strand or bar that exhibits the principal attributes of high tensile strength and ductility because of its composition and method of production.

**Reinforcing Steel Bars** means deformed steel bars made of carbon steel as defined in CAN/CSA G30.18, used for the reinforcement of concrete.

**Slip** means the axial displacement of the reinforcing bars measured relative to the mechanical connector. Displacement is measured at a rebar stress of 5% of specified yield after the mechanical connection has been loaded to a rebar stress of 50% of specified yield and then unloaded to a bar stress of 5% of specified yield.

**Splice Bar** means a reinforcing steel bar or stainless steel reinforcing bar that is further manufactured, other than by solely cutting threads, to be compatible with a specific mechanical connector.

**Splice-Reinforcing Steel** means a connection of one steel reinforcement to another by lapping, welding, mechanical couplings, or other means or the lap between sheets or rolls of welded wire fabric.

**Stainless Steel Reinforcing Bars** means deformed stainless steel bars as defined in ASTM A 955 used for the reinforcement of concrete.

**Steel Reinforcement** means all types of steel reinforcement for concrete including reinforcing steel bars, stainless steel reinforcing bars, splice bars, welded steel wire fabric, and prestressing strands and bars.

**Steel Wire Fabric** means a wire mesh fabricated by means of welding the crossing joints, available in rolls or flat sheets.

**Strand** means a group of wires laid helically over a central-core wire. A seven-wire strand would consist of six outer wires laid over a single wire core.

**Structure** means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

**Swaged** means to apply circumferential pressure to a sleeve surrounding a bar to deform the sleeve sufficiently to achieve bearing between the deformed sleeve and the deformations on the bar.

**Ultimate Tensile Strength** means the breaking load of the material per unit area established by tensile testing.

**Yield Strength** means the stress at which the material exhibits a specified deviation of proportionality of stress and strain.

**905.04 DESIGN AND SUBMISSION REQUIREMENTS**

**905.04.01 Submission Requirements**

**905.04.01.02 Working Drawings**

**905.04.01.02.01 Steel Reinforcement Working Drawings**

Three sets of steel reinforcement Working Drawings shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of placing steel reinforcement. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The Working Drawings shall include at least the following: quantity, bar size, grade, mark number, location, and spacing for all steel reinforcement.

When a metric to imperial bar size substitution is made, the placing drawings shall include the quantity, bar size, grade, location, and spacing of both the metric and the substitute imperial bar.

When bar marks are indicated on the Contract Documents and reinforcing bar lists show the same bar marks, Working Drawings are not required.

A sealed and signed copy of these drawings shall be kept at the site before and during placing of steel reinforcement.

**905.04.01.02.02 Steel Reinforcement Schedule**

Three sets of steel reinforcement schedules shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of placing steel reinforcement. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The steel reinforcement schedules shall include at least: quantity, bar size, grade, reinforcing steel bars, stainless steel reinforcing bars, type if applicable, length, and bending dimensions.

When bar marks are shown on the Working Drawings, they shall be used in the schedule.

Steel reinforcement shall be detailed according to CAN/CSA-S6, and the Structural Manual.

A sealed and signed copy of the steel reinforcement schedule shall be kept at the site prior to and during placement of steel reinforcement.

**905.04.01.03 Prestressed Concrete - Precast Members**

Submission of proposals and shop drawings for prestressed concrete-precast members shall be according to OPSS 909.

**905.04.01.04 Prestressed Concrete - Post-Tensioning**

Submissions for post-tensioning shall be according to OPSS 910.

#### **905.04.01.05                    Welding Details**

Three sets of welding details shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of steel reinforcement welding. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The welding details shall include materials, procedures, bars to be welded, location, and type of welds, as well as details of tack welds. Details shall be designed to prevent notching effects in the bars.

A sealed and signed copy of the welding details shall be kept at the site prior to and during welding of reinforcing.

#### **905.04.01.06                    Mechanical Connections Details**

Three sets of mechanical connection details shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of installation of the connectors. Prior to making a submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents.

The connections details shall contain the following information:

- a) The type or series identification of the connector.
- b) The grade and size of the reinforcement to be joined by the connector.
- c) A copy of the manufacturer's catalogue giving complete data on the connector material and installation procedures.
- d) Location of splices, including type of splice.

### **905.05                                MATERIALS**

#### **905.05.01                         Steel Reinforcement**

Steel reinforcement shall be according to OPSS 1440.

#### **905.05.02                         Post-Tensioning Materials**

Post-tensioning materials shall be according to OPSS 910.

#### **905.05.03                         Mechanical Connections Details**

##### **905.05.03.01                      Post-Tensioning Tendons**

When tested in an unbonded condition, mechanical connections for post-tensioning tendons shall develop at least 100% of the ultimate tensile strength of the tendons, without exceeding the anticipated set.

The mechanical connection shall withstand, without failure, two million cycles of stress through a range of 245 MPa for plain bars and 195 MPa for strands and ribbed bars. The upper limit of the range shall be 70% of the nominal tensile strength.

##### **905.05.03.02                      Reinforcing Steel Bars, Stainless Steel Reinforcing Bars**

The mechanical connections shall be qualified by tests made on sample splices according to the Job Control Tests clause.

Mechanical connections for steel reinforcement shall develop, in tension, at least 125% of the specified yield strength of the bars to be used, in the test of the mechanical connection.

The total slip of the reinforcing bars shall not exceed the following measured displacements between gauge points straddling the mechanical connector:

- a) for bar sizes up to and including No. 45M                      0.25 mm
- b) for No. 55M bars    0.75 mm

Splice bars shall be supplied by the manufacturer of the associated mechanical connector.

Stainless steel splice bars shall be used with stainless steel reinforcing bars and shall be of a type according to OPSS 1440.

**905.05.04                      Mechanical Connectors**

**905.05.04.01                      Post-Tensioning Tendons**

Mechanical connectors shall be supplied by the manufacturer of the prestressing system.

**905.05.04.02                      Reinforcing Steel Bars, Stainless Steel Reinforcing Bars**

Mechanical connectors shall be of an approved type and design and may be the form saver type, the filled sleeve type, the sleeve swaged coupler type, the threaded coupler type, the hot rolled thread bar coupler type, or the forged bar coupler type.

Stainless steel mechanical connectors shall be used with stainless steel reinforcing bars and shall be of a type according to OPSS 1440.

**905.05.05                      Associated Hardware**

Only hardware including spacers and support devices approved by the Owner shall be used with steel reinforcement. All supports or support systems shall be capable of withstanding the loads to be placed on them. Except for tie wire, all embedded hardware within 50 mm of exposed faces shall be coated with an acceptable material or be of an acceptable non-metallic material.

Tie wire shall be annealed ferrous wire 2.6 mm in diameter.

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.

Bar chairs for supporting stainless steel reinforcing bars shall be non-metallic. Concrete chairs shall not be used to support stainless steel reinforcing bars.

**905.07                      CONSTRUCTION**

**905.07.01                      General**

All steel reinforcement and accessories shall be kept clean of all mud, oil, and other deleterious materials and stored clear of ground contact.

Steel reinforcement shall be placed in conformance with the tolerances shown in Table 1. The tolerances listed include fabrication tolerances.

## **905.07.02                    Reinforcing Steel Bars, Stainless Steel Reinforcing Bars, and Splice Bars**

### **905.07.02.01                Storage and Protection of Stainless Steel Reinforcing Bars**

Stainless steel reinforcing bars shall be stored separately from reinforcing steel bars with the bar tags maintained and clearly visible until ready for placement.

### **905.07.02.02                Placing**

Reinforcing steel bars and stainless steel reinforcing bars shall be accurately placed in the positions as specified in the Contract Documents and held in the correct location during the operations of placing and consolidating concrete.

Bars shall be tied at least at every fourth intersection. The maximum untied length of any bar shall be 1 m.

For slab-on-girder type decks, the top layer of deck reinforcement shall be tied to the shear studs or shear stirrups on each girder at approximately 1.5 m centres.

Spacers for spirals shall be equally spaced around the spiral and shall be so that the specified pitch of the spiral is maintained.

### **905.07.02.03                Surface Condition**

Steel reinforcement other than stainless steel reinforcing bars with rust, mill scale, or a combination of both shall be acceptable, provided the minimum physical properties including height of deformations and mass of a wire brushed test specimen are not less than the applicable specification requirements. Loose scale shall be removed.

Stainless steel reinforcing bars at the time the concrete is placed shall be free of deposits of iron and non-stainless steels.

### **905.07.02.04                Cutting**

The cutting of stainless steel reinforcing bars, reinforcing steel bars, and splice bars by oxyacetylene torch may be carried out only where permitted in writing by the Contract Administrator.

### **905.07.02.05                Bending**

Field bending of stainless steel reinforcing bars and reinforcing steel bars shall not be permitted, except when specified in the Contract Documents or authorized by the Contract Administrator.

### **905.07.02.06                Welding**

Welding, including tack welding, shall not be permitted except as specified in the Contract Documents or as shown on the welding details submitted to the Contract Administrator.

The welding of stainless steel reinforcing bars and reinforcing steel bars shall be according to CSA Standard W186 and shall be performed by companies certified by the Canadian Welding Bureau according to CSA W186.

Welding shall not be permitted within 3 m of any prestressing steel. Grounding welding equipment to prestressing steel or sheath shall not be permitted.

Except for splicing of stainless spirals, welding of stainless steel reinforcing bars shall not be permitted.

#### **905.07.02.07 Splicing**

Welded splices shall develop 100% of the tensile strength of the bar.

Splices for stainless steel reinforcing bars and reinforcing steel other than spirals shall be made as specified in the Working Drawings.

End anchorage of column spiral reinforcement shall be provided either by one and one half extra turns of spiral bar at each end of the spiral, one end embedded in the footing and the other end in the component supported above, or by a 90 degree bend around a longitudinal reinforcing bar plus an extension of at least 24 bar diameters into the core of the column.

Splicing of spiral reinforcing bars by means of a non-welded splice shall be made as specified in the Working Drawings. Non-welded splices shall be effected by mechanical connections or anchoring the ends of the spiral bars by means of a 90 degree bend around a longitudinal reinforcing bar with extensions of at least 24 bar diameters into the core of the column.

#### **905.07.02.08 Mechanical Connections**

Mechanical connections shall only be permitted as specified in the Contract Drawings.

Locations of mechanical connections shall be as specified in the Working Drawings.

When a mechanical connector type is specified in the Contract Documents, only the specified mechanical connector type shall be used for that application.

The form saver type of mechanical connector shall only be used at construction joints.

The mechanical connections shall be qualified by tests made on sample splices according to the Job Control Tests clause.

All procedures and equipment for mechanical connections shall be according to the manufacturer's recommendations.

Ends of reinforcing bars to be joined shall be cut nominally square.

Connector sleeves shall have the clear cover as specified for the reinforcing steel in that location.

Stirrups, ties, and other reinforcement shall be adjusted or relocated, if necessary, to provide the required clear cover to the reinforcement.

Threads cut on the ends of the reinforcing steel bars shall match the internal threads in the connector.

#### **905.07.02.08.01 Job Control Tests**

When mechanical connectors are used, sample connections shall be assembled at the work site in the presence of the Contract Administrator to be used for testing by the Owner. Frequency of sampling and method of sample assembly shall be according to the Quality Assurance section.



**905.07.02.08.02 Interim Inspection After Installation of Mechanical Connectors**

Upon completion of job control testing and installation of connectors, and prior to placing of concrete, the Quality Verification Engineer shall conduct an interim inspection of the work to verify that the mechanical connectors meet the requirements of and are installed in general conformance with the Contract Documents.

**905.07.03 Prestressing Steel for Prestressed Concrete**

**905.07.03.01 Surface Condition**

All prestressing steel shall be clean and free of all rust, oil, dirt, scale, and pitting. Prestressing steel may have a light oxide coating.

**905.07.03.02 Placing**

Prestressing steel shall be accurately placed in the positions as specified in the Contract Documents and held in the correct location during the operations of placing and compacting concrete.

Prestressing steel shall be placed according to the tolerances shown in Table 1.

Mechanical connections in strand or high strength bars shall not be permitted in the work, unless specified in the Contract Documents.

Mechanical connections shall be installed according to the recommendations of the manufacturer of the prestressing system used.

**905.07.03.03 Welding**

Welding of prestressing strand shall not be permitted.

**905.07.04 Stressing Systems for Post-Tensioning**

Construction requirements for stressing systems for post-tensioning shall be according to OPSS 910.

**905.07.05 Certificate of Conformance for Placing Reinforcement**

Upon completion of placing reinforcement for each component and prior to placing of concrete, a certificate of conformance sealed, signed, and dated by the Quality Verification Engineer shall be submitted to the Contract Administrator. The certificate shall state that the Work has been carried out in general conformance with the sealed and signed Working Drawings and Contract Documents.

The certificate of conformance requirements of this specification do not apply to footings and pads for electrical equipment that are constructed according to OPSS 616.

**905.07.06 Management of Excess Material**

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

**905.08                      QUALITY ASSURANCE**

**905.08.01                  Sampling**

**905.08.01.01              Prestressing Steel**

The Contractor shall notify the Contract Administrator when prestressing steel is available for sampling.

Samples selected by the Contract Administrator shall be properly labeled by the Contractor for submission at least 3 weeks in advance of anticipated use to the Owner's laboratory or as directed by the Contract Administrator.

Samples of the prestressing steel shall be provided as follows:

- a) For strand, 1 sample 1.0 m long from each reel.
- b) For anchorages and connectors, samples shall be selected by the Contract Administrator on a random basis.

**905.08.01.02                  Reinforcing Steel Bars and Stainless Steel Reinforcing Bars**

The sampling of reinforcing steel bar shall be at the discretion of the Contract Administrator and shall be on a random basis.

Three 1.5 m long randomly selected samples of each bar size supplied in a lot of stainless steel reinforcing bars shall be submitted to the Contract Administrator with the mill certificates for that lot.

The Contractor shall deliver the samples of reinforcing steel bar and stainless steel reinforcing bars to:

Head, Concrete Section  
Ontario Ministry of Transportation  
Room 15, Building C  
1201 Wilson Avenue  
Downsview, Ontario, M3M 1J8

**905.08.01.03                  Mechanical Connectors - Sampling for Job Control Test**

Mechanical connectors shall be sampled for acceptance on a lot basis. A lot shall consist of all connectors of one size and type from one supplier. If a lot contains more than 300 connectors, it shall be divided into sublots of a maximum of 300 connectors. Sublots shall be of approximately equal size.

The Contractor shall assemble three sample connections per subplot or three sample connections per lot if there are less than 300 connectors. The reinforcing bars from which the test samples are to be fabricated shall be selected on a random basis at the site by the Contract Administrator. The length of each bar to be joined shall be at least 500 mm. The same materials, position, location, equipment, and procedures as are being used to make connections in the reinforcing bars in the work shall be used when making the sample connections.

Each assembled test sample shall be tagged with a weatherproof marking, which clearly identifies the Contract number, subplot number, connector bar size, number of connectors within the subplot, date of supply to the Contract site, and name of manufacturer. The Contractor shall deliver the samples to the Regional Quality Assurance laboratory with mill test certificates representative of the steel reinforcement used.

**905.08.02                    Testing**

**905.08.02.01                Prestressing Steel**

The testing of prestressing steel shall be according to ASTM A 421M.

**905.08.02.02                Reinforcing Steel Bar and Stainless Steel Reinforcing Bar**

The testing of reinforcing steel bar and stainless steel reinforcing bar shall be according to ASTM A 276 and A 955.

**905.08.02.03                Mechanical Connections**

**905.08.02.03.01            Testing for Torque**

The torque shall be checked on 5% of the splices. Formwork that limits access to connectors for testing purposes shall not be placed until testing has been completed.

**905.08.02.03.02            Job Control Test**

Mechanical connectors shall be tested for slip and tensile strength according to the ministry's laboratory test method LS-434.

If any one of the three test samples for a subplot fails either the slip test or the strength test, then two new referee sample connections shall be prepared by the Contractor from the same subplot and tested along with the remaining connectors.

In this case a total of four samples are required to meet requirements for slip and tensile strength for the subplot to be considered acceptable. If any of the new samples do not meet the requirement of the slip test or the tensile strength test, the subplot shall be rejected.

The above procedure shall be repeated for the next subplot. If an additional subplot fails, then the remainder of the lot shall be rejected and the Contractor shall submit to the Contract Administrator a proposal for replacing this lot for his approval.

Only qualifying sublots shall be used in the work.

**905.09                        MEASUREMENT FOR PAYMENT**

**905.09.01                    Actual Measurement**

**905.09.01.01                Mechanical Connectors  
Stainless Steel Mechanical Connectors**

For measurement purposes, a count shall be made of the number of connectors installed.

**905.09.02                    Plan Quantity**

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

**905.10 BASIS OF PAYMENT**

**905.10.01 Reinforcing Steel Bar - Item  
Stainless Steel Reinforcing Bar - Item**

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

**905.10.02 Mechanical Connectors - Item  
Stainless Steel Mechanical Connectors - Item**

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

**TABLE 1**  
**Tolerances for Cover and Placing Accuracy**

TYPE	TOLERANCE mm	
	CAST-IN-PLACE CONCRETE	PRECAST CONCRETE
<b>STEEL REINFORCEMENT</b>	<b>Cover to Surface of Concrete and Placing Accuracy</b> (Notes 1 and 2)	
a) Principal Steel Reinforcement	± 20	± 10
b) Concrete Cast Against and Permanently Exposed to Earth	± 25	
c) Stirrups in Webs		+ 5, - 3
d) Stirrups, Ties, Spirals	± 20	± 10
e) Deck Slab i) Top ii) Bottom	± 20 ± 10	± 15 ± 10
f) Remainder	± 30	± 30
g) Lateral spacing in slabs and walls	± 30 Note 3	± 30 Note 3
h) Longitudinal location of bends and ends of bar in continuous member	± 50	± 50
i) Longitudinal location of bends and ends of bar at discontinuous end	± 20	± 20
<b>PRESTRESSING STEEL</b>	<b>Placing Accuracy Horizontal and Vertical</b>	
a) Prestressing strands or bars		± 5

Notes:

1. The cover to the concrete surface shall not be reduced by more than one-third of the specified cover.
2. The clear distance between bars shall not be less than one and one-half times the nominal diameter of the bar, one and one-half times the nominal size of the coarse aggregate, or 40 mm.

In two or more layers, the rebar shall be directly above one another and the clear distance between layers shall not be less than 25 mm.

The tolerances e) through f) do not apply to the lateral spacing of bars in slabs and walls.

3. The number of bars specified per metre width shall be placed in the metre width.

**Appendix 905-A, November 2014  
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

**Note:** This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

**Designer Action/Considerations**

No information provided here.

**Related Ontario Provincial Standard Drawings**

No information provided here.