



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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

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

Ontario Provincial Standard Specifications, Construction

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
S6-14 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 416 / A 416M-02	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
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:

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Lot means a quantity of steel that can be identified. For each size designation of prestressing steel strand, a lot shall be reels or coils produced from one heat. For each nominal diameter of prestressing steel bar and for each size designation of reinforcing steel bar, a lot shall be all the supplied bars from one heat.

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.

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

Two hardcopies and an electronic PDF 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, spacing for all steel reinforcement and type if applicable.

When a metric to imperial bar size substitution is made, the placing drawings shall include the quantity, bar size, grade, location, spacing and type if applicable 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

Two hardcopies and an electronic PDF 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

Two hardcopies and an electronic PDF 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

Two hardcopies and an electronic PDF 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.

- b) Except for tie wire, embedded hardware within 50 mm of exposed surfaces shall be stainless steel, galvanized steel, or of a non-metallic material verified not to react with concrete and approved by the Owner prior to use.
- c) Tie wire shall be annealed ferrous wire except for tie wire used to tie stainless steel reinforcing bars to stainless steel reinforcing bars, reinforcing steel bars and shear studs, which shall be Type 316LN or Type 316L stainless steel wire. Tie wire shall be capable of securing reinforcement firmly in place during construction operations. Tie wire shall have a minimum diameter of 1.2mm.
- d) Bar chairs for supporting stainless steel reinforcing bars shall be non-metallic. Concrete chairs shall not be used to support stainless steel reinforcing bars.
- e) Concrete chairs shall not be used except in footings and against granular surfaces.

905.07 CONSTRUCTION

905.07.01 General

All steel reinforcement and accessories shall be kept clean of 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

Bar tags shall be maintained and clearly visible until ready for placement.

905.07.02.01 Storage and Protection of Stainless Steel Reinforcing Bars

Stainless steel reinforcing bars shall be stored separately from reinforcing steel bars.

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 position 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 evenly spaced.

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 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 done means of 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 Test 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 Test

When mechanical connectors are used, sample connections shall be assembled at the work site in the presence of the Contract Administrator. Frequency of sampling and method of sample assembly shall be according to the Quality Assurance section. Sample connections for testing shall be assembled on site in exactly the same manner as the connectors used in the work. Sample connections fully assembled anywhere other than on site and in the presence of the Contract Administrator shall not be submitted for testing.

Samples for testing shall be submitted at least 10 Days prior to intended start of concrete placement.

905.07.02.08.02 Inspection of Mechanical Connectors

The Contractor shall provide the Contract Administrator two Days' notice prior to the projected completion of the installation of mechanical connectors to allow the Contract Administrator to complete the inspection of the work.

905.07.03 Prestressing Steel for Prestressed Concrete

Prestressing steel shall be according to OPSS 910

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 Inspection of Reinforcement

The Contractor shall provide the Contract Administrator two Days' notice prior to the projected completion of the installation of reinforcement to allow the Contract Administrator to complete the inspection of the work.

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

Sampling of the prestressing steel shall be as per OPSS 910

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.

The sampling of stainless steel reinforcing bars shall consist of three bars, 1.5 m long, randomly selected samples of each bar size supplied in a lot, and 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 the Owner's designated laboratory or as directed by the Contract Administrator.

905.08.01.03 Mechanical Connectors - Sampling for Job Control Test

At the discretion of the Contract Administrator, 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 six sample connections per subplot or six 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.

The Contractor shall complete Form PH-CC-812, Field Sample Data Sheet-Mechanical Connectors, for each assembled sample. The Contractor shall submit the samples and the completed forms along with mill test certificates corresponding to the bars used, to the Contract Administrator for delivery to the laboratory designated by the Owner.

905.08.02 Testing

905.08.02.01 Prestressing Steel

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

The testing of prestressing steel strand and bars shall be according to ASTM A 416.

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

Three of the six sample connections for each lot or subplot shall be tested for acceptance and the remaining three samples shall be retained by the testing laboratory for referee testing, if invoked.

The samples shall be tested for slip and tensile strength according to the Ontario Ministry of Transportation laboratory test method LS-434.

If one or more of the three test samples fails to meet the requirements of this specification for either the slip or tensile strength, the lot or subplot represented by the samples shall be rejected.

Individual test results shall be forwarded to the Contractor, as they become available.

905.08.02.03.03 Job Control Test - Referee Testing

Referee testing of mechanical connectors may be invoked by the Contractor, at no extra cost to the Owner, within five Days of receiving the test result.

When referee testing is invoked, the three retained referee samples will be tested by the referee laboratory designated by the Owner . The samples shall be tested for slip and tensile strength according to LS-434.

Referee test results shall be forwarded to the Contractor, as they become available.

If one or more of the referee samples fails to meet the requirements of this specification for either the slip or tensile strength, the Acceptance Testing results are confirmed and shall be the basis of acceptance.

When all three referee samples meet the requirements of this specification for slip and tensile strength, the Acceptance Testing results are not confirmed and the referee test results shall replace the Acceptance Testing results as the basis of acceptance.

905.08.02.03.04 Referee Testing Cost

The cost of mechanical connector referee testing shall be as specified in the Contract Documents. When the referee results indicate that the acceptance test results for refereed lot or subplot are not confirmed, the Owner shall bear the cost. When the referee results indicate that the acceptance test results for refereed lot or subplot are confirmed, the Contractor shall be charged the cost of mechanical connector testing.

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
STEEL REINFORCEMENT	Cover to Surface of Concrete and Placing Accuracy (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
PRESTRESSING STEEL	Placing Accuracy Horizontal and Vertical	
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 2017
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

The designer should specify the following in the Contract Documents:

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- Where field re-bending of bars is permitted, if required. (905.07.02.05)
- Where welding of steel reinforcement is permitted, if required. (905.07.02.06)
- Specify location and type of Mechanical connections, if required. (905.07.02.08)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.