

Part 1 General

1.01 DESCRIPTION OF WORK

- .1 This section specifies requirements for concrete formwork, falsework, and their accessories for concrete construction.
- .2 The Work includes design, construction, erection, and removal of concrete formwork, falsework, and accessories.

1.02 REFERENCE STANDARDS

- .1 Current editions of reference standards shall be applicable.
- .2 Canadian Standards Association (CSA):
 - .1 CSA A23.1-14, Concrete Materials and Methods of Concrete Construction.
 - .2 CSA A23.2-14, Methods of Test for Concrete.
 - .3 CSA S269.1-16, Falsework for Construction Purposes.
 - .4 CAN/CSA-S269.3-M92 (R2013), Concrete Formwork.
- .3 American Concrete Institute (ACI):
 - .1 ACI 315, ACI Detailing Manual-2004.
 - .2 ACI 347R-14, Guide to Formwork for Concrete.

1.03 DESIGN

- .1 Design of concrete formwork and falsework are the responsibility of the Contractor.

1.04 SUBMITTALS

- .1 Submittals shall be in accordance with Section 01300 Submittals and CSA A23.1.
- .2 Submit shop drawings of proposed formwork and/or falsework for review if requested.
- .3 Show material sizes and grades and spacing of members.
- .4 Indicate rate and sequence of concrete placing used in design of formwork.
- .5 Shop drawings shall bear the stamp of a qualified Professional Engineer registered in Manitoba.
- .6 Submit for review shoring and reshoring provisions and removal schedules.
- .7 Submit for review proposed hoarding and heating methods for cold weather concreting.

Part 2 Products

2.01 FORMS

- .1 Use material of suitable strength and quality to produce the specified surface finish.
- .2 Use forms which are watertight, non-warped, non-absorbent, and non-staining.
- .3 Formwork lumber: plywood and wood formwork materials to CSA A23.1.
- .4 Falsework materials: to CSA S269.1, Table 1- Materials shall bear grade marks or be accompanied with certificates, test reports, or other proof of conformity.

2.02 FORM TIES

- .1 Form ties shall be removable snap off metal type, fixed length, minimum working strength of 13 kN when assembled; free of defects that will leave holes deeper than 25 mm from concrete surface. Use plastic cone snap type or screw type and light grey concrete plugs on exposed surfaces. Wire ties are not permitted.

2.03 ACCESSORIES

- .1 Form Release Agent: chemically reactive release agents containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing set of film on concrete in contact with form. Agent to not stain concrete or impair natural bonding or colour characteristics of coating intended for use on concrete.
- .2 Fillets for chamfered corners: unless otherwise indicated 25 x 25 mm. Special sizes, shapes, and profiles as indicated on drawings.

Part 3 Execution

3.01 INSPECTION

- .1 Notify the Departmental Representative to permit inspection of formwork at least 72 hours before concreting. Inspection by Departmental Representative of formwork shall be for conformance to project specifications, but not for structural strength and stability, which is the sole responsibility of the Contractor.
- .2 Obtain approval from Departmental Representative prior to placing concrete.

3.02 FORMS

- .1 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated on Drawings within tolerances required by CSA A23.1.
- .2 Make all form joints watertight.
- .3 Make form surfaces smooth and flat.
- .4 Clean formwork in accordance with CSA A23.1 before placing concrete.
- .5 Form release agent:
 - .1 Apply on formwork in accordance with manufacturer's instructions.
 - .2 Apply prior to placing reinforcing steel, anchoring devices and embedded parts.
 - .3 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.
 - .4 Take precautions to keep form release agent from contacting reinforcing steel.
- .6 Provide chamfers at all vertical and horizontal exposed exterior corners.
- .7 Provide access for cleaning prior to concreting.
- .8 Do not use temporary removable spacers or blocks to support reinforcement or other items unless approved by the Departmental Representative.
- .9 Finished concrete exhibiting evidence of excessive form displacement, and/or excessive deflection shall be cause for rejection of the work and its removal and replacement at the Contractors own expense.

- .10 Obtain Departmental Representative's approval before framing openings not indicated on drawings.

3.03 TOLERANCES

- .1 Construct formwork to maintain the tolerances of concrete work in accordance with CSA A23.1.

3.04 PLACING OF CONCRETE

- .1 Inform Departmental Representative when formwork is complete and has been cleaned to allow for inspection. Obtain approval prior to placing concrete.
- .2 Make a final inspection and ensure that forms are satisfactory and no deleterious materials are present inside the area to be concreted.
- .3 Observe forms during concreting operations and correct any displacement of the form.

3.05 FORM REMOVAL

- .1 Remove forms so that no damage occurs to the concrete. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against concrete surfaces.
- .2 Consider the location, character of the structure, weather, and other conditions influencing the curing of concrete, in determining the time for removal of forms. Refer to Section 03 30 00 – Cast-in-Place Concrete and CSA A23.1.
- .3 Leave shores in place until concrete has attained sufficient strength to adequately support its own weight together with construction loads likely to be imposed. Leave formwork in place for the minimum periods of time after placing concrete.
- .4 Reshore structural members where required due to design requirements or construction conditions and as required to permit progressive construction. Remove forms supporting loads only when concrete has attained 75% of required compressive strength, provided construction is reshored.
- .5 Remove formwork progressively and in accordance with Building and Safety Code requirements and so that no shock loads or unbalanced loads are imposed on structure.
- .6 Concrete curing procedures shall commence immediately after form removal. Refer to Section 03 30 00 – Cast-in-Place Concrete for leaving some formwork in place as part of curing procedures.
- .7 Re-use of formwork and falsework subject to requirements of CSA A23.1.

END OF SECTION

Part 1 General

1.01 DESCRIPTION OF WORK

- .1 This section specifies requirements for the supply, fabrication, and placing of reinforcing steel, including necessary supports, spacers, and related accessories.

1.02 REFERENCE STANDARDS

- .1 Current editions of reference standards shall be applicable.
- .2 CSA A23.1-14, Concrete Materials and Methods of Concrete Construction.
- .3 CSA A23.3-14, Design of Concrete Structures.
- .4 CSA G30.18-09 (R2014), Billet-Steel Bars for Concrete Reinforcement.
- .5 ASTM A1064/A1064M-16, Welded Steel Wire Fabric for Concrete Reinforcement.
- .6 ACI 315, ACI Detailing Manual-2004.
- .7 CRSI Manual of Standard Practice-2009.

1.03 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01300 - Submittals, at least 10 days before fabrication.
- .2 Submit bending schedules and placing drawings.
- .3 Show bar size, spacing, location, and quantities to permit correct placement without reference to Drawings.
- .4 Provide details to show placement of reinforcing where special conditions occur.
- .5 Details shall be in accordance with ACI 315.
- .6 Submit certificates and mill tests for the material supplied as requested by the Departmental Representative.
- .7 Design and detail lap lengths and bar development lengths to CSA A23.3 unless otherwise indicated.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- .1 Ship bar reinforcement in standard bundles, easily identifiable, and marked in accordance with the bar lists.
- .2 Store reinforcement to prevent deterioration or contamination by dirt, detrimental rust, loose scale, paint, oil, or other foreign substances that will destroy or reduce bond.
- .3 Do not straighten or re-bend reinforcement in any manner.
- .4 Do not use bars kinked or bent by improper handling or storage.

Part 2 Products

2.01 REINFORCING STEEL

- .1 Reinforcing steel to meet CSA G30.18. Steel grade to be 400 MPa.
- .2 Welded steel wire fabric to ASTM A1064/A1064M, provide in flat sheets only.

2.02 CHAIRS, BOLSTERS, BAR SUPPORTS, SPACERS

- .1 Provide adequate support of reinforcement (according to CRSI Manual of Standard Practice).
- .2 Precast concrete block supports must be equal in strength and quality to the concrete in the structure and with a maximum plan dimensions of 50x50mm.
- .3 Chairs, bolster bar supports, and spacers shall have sufficient strength to support the reinforcing under normal construction conditions. Brick shall not be used for bar supports.
- .4 Side form spacers to be non-corrosive PVC spacers, purpose made. Steel bar chairs, galvanized bar chairs, PVC chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.

2.03 FABRICATION

- .1 Fabricate reinforcing steel from bar sizes and grades indicated within the following tolerances:
 - .1 Sheared length: plus 0, minus 25 mm.
 - .2 Stirrups, ties, and spirals: plus 0, or minus 13 mm.
 - .3 Location of bends: plus 0, or minus 25 mm.
- .2 Unless otherwise indicated, fabricate in accordance with CSA A23.1.
- .3 Obtain Departmental Representative approval for location of reinforcing splices other than as shown on reviewed reinforcing steel placing drawings.

Part 3 Execution

3.01 INSPECTION

- .1 Notify Departmental Representative to permit review after placement is completed. Reinforcing for all concrete pours shall be reviewed after placing and prior to concreting.
- .2 Provide adequate notice of scheduled pours to facilitate review of reinforcement (minimum of 72 hours).

3.02 PLACING OF REINFORCEMENT

- .1 Place reinforcement as shown on the reviewed shop drawings and in accordance with CSA A23.1.
- .2 Support reinforcement in position as follows:
 - .1 Piers - laterally support reinforcement with supports in pairs on opposite faces.
 - .2 Do not use supports which will be forced into the supporting formwork or soil by the weight of the reinforcement or other construction loads.
 - .3 Separate layers of bars by precast mortar blocks, bars, or equally suitable devices. Do not use pebbles, pieces of broken stone or brick, metal pipe, or wooden blocks.

- .4 Do not place bars on layers of fresh concrete as the work progresses or install bars during placing of concrete.
- .3 Provide concrete 75mm concrete cover to light standard pier reinforcing.

3.03 WELDING OF REINFORCEMENT

- .1 Welding of reinforcing bars is not permitted.

3.04 SPLICING OF REINFORCEMENT

- .1 Splice bars only as shown on the Drawings or approved by the Departmental Representative.
- .2 Bar splices shall conform to CSA A23.3, Type B, unless noted.

END OF SECTION

Part 1 General

1.01 DESCRIPTION OF WORK

- .1 This section specifies requirements for design and preparation of the concrete mix, handling, placing, finishing and curing of cast-in-place concrete.

1.02 REFERENCE STANDARDS

- .1 Current editions of reference standards shall be applicable.
- .2 Canadian Standards Association (CSA):
 - .1 CSA A23.1-14, Concrete Materials and Methods of Concrete Construction.
 - .2 CSA A23.2-14, Methods of Test for Concrete.
 - .3 CSA A23.3-14, Design of Concrete Structures.
 - .4 ACI 350-06, Code Requirements for Environmental Engineering Concrete Structures.
 - .5 CAN/CSA-A3000-13, Cementitious Materials Compendium.
- .3 ASTM International (ASTM):
 - .1 ASTM C94/C94M-16, Standard Specification for Ready-Mixed Concrete.
 - .2 ASTM C260/C260M-10, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .3 ASTM C494/C494M-15, Standard Specification for Chemical Admixtures for Concrete.
 - .4 ASTM C1017/C1017M-13, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

1.03 QUALITY CONTROL PLAN

- .1 Cast-in-place concrete shall conform to the CSA A23.1. Concrete shall be delivered under the Performance Alternative as outlined in CSA A23.1, Table 5.
- .2 The Contractor shall be fully responsible for quality control of all aspects of production, pre placement, placement, and post-placement of concrete and related testing.
- .3 Concrete testing shall be performed by a CSA A23.1 certified Testing Agency. Testing shall conform to CSA A23.1/A23.2. Testing shall be paid for by the Contractor.
- .4 Contractor to assume 1 set of 3 test cylinders per day of concrete pouring and/or up to a maximum of 75 m³ of concrete.
- .5 Distribute the Testing Agency test data to Departmental Representative immediately upon receiving.
- .6 Submit and implement a Quality Control Plan a minimum of four (4) weeks prior to first scheduled concrete casting; the Quality Control Plan shall include:
 - .1 Identify the Quality Control Manager.
 - .2 Concrete supplier certification with Manitoba Ready Mixed Concrete Association.
 - .3 Qualifications of construction supervisory personnel.
 - .4 Quality Control testing plan for concrete.
 - .5 Pre-placement procedures, checklists, and project specific finishing procedures for concrete.

- .6 During placement contingency plans and procedures.
- .7 Post-placement procedures and checklists for concrete.
- .7 Submit mix design statements for each type of concrete:
 - .1 Mix design statements shall be sealed and signed by a Professional Engineer registered in the Province of Manitoba experienced in preparing concrete mix designs.
 - .2 Submit documentation a minimum of four (4) weeks prior to the first scheduled concrete casting demonstrating that the proposed mix designs and materials will achieve the required strength, durability, and performance requirements.
 - .3 The mix design statements shall clearly correlate to the concrete specifications as indicated below:
 - Foundations and tunnel crossing curb:
 - .1 Exposure Class: S-2
 - .2 Cement type HS (Sulphate resistant)
 - .3 Minimum compressive strength at 56 days: 35 MPa
 - .4 Maximum aggregate size: 20 mm
 - .5 Air content category: 2 (4-7%)
 - .6 Chemical admixtures in accordance with ASTM C494 and ASTM C1017

1.04 QUALITY ASSURANCE

- .1 Notify the Departmental Representative at least 72 hours before complete formwork, embedded items, and concrete reinforcement is ready for review. Contractor shall schedule review of embedded items and reinforcing in walls prior to closing forms.
- .2 Allow ample time for review, and corrective work, if required, before scheduling concrete placement.
- .3 The Owner reserves the right to arrange and pay for a CSA A23.1 certified Testing Agency to test the concrete works. Provide unencumbered access to all portions of the Work and cooperate with appointed Testing Agency.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- .1 Store all material in accordance with CSA A23.1, Storage of Materials, except as otherwise noted.
- .2 Store each shipment of cement separately to provide access to identification and inspection of each shipment.
- .3 Clean stockpile areas of foreign materials.
- .4 Do not use stockpiled material within 150 mm of the ground surface if the stockpile is placed directly on the ground.

Part 2 Products

2.01 CONCRETE MATERIALS

- .1 Portland Cement: Type HS or HSb conforming to CSA A3000.
- .2 Supplementary cementing materials: conforming to CSA A3000.
- .3 Fine and coarse aggregate: conforming to CSA A23.1.

- .4 Water: potable, clean, and free from injurious amounts of oil, alkali, organic matter, or other deleterious matter, meeting requirements of CSA A23.1.
- .5 Materials are to be obtained from the same source of supply or Manufacturer for the duration of the project.

2.02 ADMIXTURES

- .1 Air entrainment: to ASTM C260/C260M.
- .2 Chemical admixtures, water-reducing agent, superplasticizer: to ASTM C494/C494M and ASTM C1017/C1017M.
- .3 Admixtures containing chlorides will not be permitted.

2.03 CONCRETE MIXES

- .1 Provide concrete mixed in accordance with requirements of CSA A23.1 and this specification Section. Pay all costs for the mix designs.
- .2 Concrete design compressive strength and class of exposure as indicated in section Cast-in-Place Concrete 03 30 00 section 1.3.6.3. Concrete mixes are to be designed to mitigate dry and plastic temperature and shrinkage cracks.
- .3 Use accelerating admixtures in cold weather only when accepted by the Department Representative. If accepted, the use of admixtures will not relax cold weather placement requirements. Do not use calcium chloride.
- .4 Use set-retarding admixtures during hot weather only when accepted by the Department Representative.
- .5 All admixtures are subject to acceptance by the Department Representative.
- .6 Concrete delivered to site must be accompanied by a delivery slip in accordance with CSA A23.1.

2.04 CONCRETE CURING COMPOUND

- .1 Chlorinated rubber type compound conforming to CSA A23.1, Type 1.
- .2 Where waterproofing is to be applied, ensure adequate surface preparation of the concrete for proper bonding.

2.05 SLURRY MIX

- .1 Slurry mix to have an excess of mortar to achieve good flowing characteristics.

2.06 MIXING

- .1 Ready-mixed concrete:
 - .1 Mix premixed or Transit-mixed concrete according to CSA A23.1 and to ASTM C94.
 - .2 Ensure that the concrete supplier has sufficient plant capacity and transporting apparatus to provide delivery so that the interval between successive loads does not exceed 15 minutes.
- .2 Site-Mixed Concrete shall be in accordance with CSA A23.1.

Part 3 Execution

3.01 PRE-INSTALLATION MEETING

- .1 Pre-installation Meeting for cast-in-place concrete: one week prior to installation of concrete works, the Contractor shall conduct a meeting with mix designer, batch plant Quality Control Manager, Testing Agency Representative, concrete installers, concrete finishers, concrete curing applicators, reinforcing steel installers, installers of work adjacent to or that penetrates the concrete works, and the Department Representative to review the following:
 - .1 General project requirements.
 - .2 Contractor's Quality Control Plan for each class of concrete.
 - .3 Contractor's procedures prior, during, and following concrete placements.
- .2 Provide agenda and meeting minutes. Distribute agenda to the attendees 4 days prior to the Pre-installation Meeting. Distribute Pre-installation Meeting minutes within 4 days of the meeting.
- .3 Pay for all costs associated with the pre-installation conference excluding the Department Representative cost.

3.02 INSPECTION

- .1 Immediately before concrete is placed, Contractor shall carefully inspect all forms in accordance with Section 03 10 00, to ensure that they are properly placed, sufficiently rigid and tight, and that all reinforcing steel and embedded parts are in the correct position and secured against movement during the placing operation. All forms shall be thoroughly cleaned and material removed.
- .2 The Department Representative will review forms, foundations, reinforcing steel, mixing, conveying, placing equipment, and curing preparations before concreting.

3.03 PREPARATION

- .1 Do not place concrete on soil that has been softened by mechanical disturbance or moisture.
- .2 Retighten forms at construction joints.
- .3 Roughen, thoroughly remove foreign matter and laitance, and saturate the hardened concrete at construction joints with water prior to concreting.
- .4 Make suitable arrangements to prevent damage to fresh concrete by adverse weather conditions, such as rain, wind, or extreme temperatures.
- .5 Concrete shall not be poured against frozen ground, frozen concrete, or into frosted formwork.
- .6 Prepare all sleeves and ducts to be cast into concrete at the same time as the concrete formwork to ensure that correct assembly, fit, and location is obtained.
- .7 Check mechanical and electrical Drawings for sleeves, inserts, etc.
- .8 Set sleeves, ties, anchor bolts, and other inserts and openings in concrete as required.

3.04 INSERTS

- .1 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of all modifications from the Department Representative before placing of concrete.

- .2 Check locations and sizes of sleeves, openings, etc., shown on structural Drawings and electrical Drawings.

3.05 PLACING OF CONCRETE

- .1 Place concrete in accordance with CSA A23.1, and as specified herein.
- .2 All formwork shall be cleaned of all debris, loose material, snow, and ice immediately prior to pouring.
- .3 Ensure proper placement and support of reinforcement and embedded material immediately ahead of a pour.
- .4 Do not temporarily displace reinforcement for convenience in placing concrete.
- .5 Do not use wood or other temporary spreaders or spacers.
- .6 Do not insert reinforcement into fresh concrete.
- .7 Confine concrete in a suitable vertical drop pipe to within 1.0 m or less of the concrete in place.
- .8 Ensure that concrete is adequately consolidated in the forms.
- .9 Place concrete in such a manner that the concrete in the form is still plastic and can be integrated with fresh concrete.

3.06 COLD AND HOT WEATHER REQUIREMENTS

- .1 Deliver, place, and cure concrete in hot or cold weather in accordance with the requirements in CSA A23.1.

3.07 CONSTRUCTION TOLERANCE

- .1 Concrete work shall be carefully and accurately set out; true to the positioning, levels, slopes, and dimensions shown on the Drawings and conforming to the following tolerances:
 - .1 Sizes of member or thickness of slabs: + 6 mm, - 0 mm.
 - .2 Cover of concrete over reinforcement: ± 3 mm.
 - .3 Variations from plumb: 6 mm in 3.0 m, 10 mm maximum.
 - .4 Variations from flat: 3 mm in 3.0 m, 6 mm maximum.
- .2 If these tolerances are exceeded the Contractor may, at the discretion of the Department Representative, be required to remove and replace or to modify the placed concrete before acceptance. The costs incurred by the Department Representative for such investigation, testing, or review of reconstruction and the cost of reconstruction shall be borne by the Contractor.

3.08 JOINTS

- .1 Carefully finish all face edges exposed to view true to line and elevation. Apply a neat cement paste or approved bonding agent to the hardened concrete immediately in advance of the fresh concrete.
- .2 Place curbs monolithically.

3.09 FINISHING

- .1 Finishing to conform to CSA A23.1 and as specified herein.
- .2 Finishing Concrete Surfaces:

- .1 Troweled finish for foundations:
 - .1 After completion of floated surface finish, trowel to produce a dense smooth finish.
 - .2 Follow with additional steel troweling to produce smooth burnished surface.
 - .3 Apply curing compound to manufacturer's instructions.

3.10 CURING

- .1 Cure and protect freshly placed concrete in accordance with CSA A23.1 and as specified herein.
- .2 All other concrete shall receive moist curing for a period of at least 7 calendar days. One of the following methods shall be used as soon as the concrete has hardened sufficiently to prevent marring:
 - .1 Surface covered with canvas or other satisfactory material and kept thoroughly and continuously wet with soaker hoses.
 - .2 A liquid membrane forming curing sealer, applied at the rate recommended by the Manufacturer. Curing sealer shall not be used on a surface where bond is required for the finishes.
 - .3 Surfaces of concrete that are protected by formwork that is left in place for 7 calendar days, shall not require any additional curing (except as specified for hot weather). If the formwork is removed in less than 7 calendar days, the concrete shall receive moist curing as above.
- .3 No concreting will be allowed until all materials required for the curing phase are on-site and ready for use.
- .4 Concrete that is allowed to freeze or attain insufficient curing conditions shall be subject to all necessary investigations and testing as deemed necessary by the Department Representative and all such concrete shall be removed and the portion reconstructed as directed by the Department Representative, at the Contractor's cost.
- .5 Supply and arrange for water for curing concrete.

3.11 FORM REMOVAL

- .1 Forms shall not be removed until removal operations will cause no damage to concrete surfaces.
- .2 At the end of the curing and protection period, the temperature of the concrete shall be reduced gradually at a rate meeting both the requirements of CSA A23.1 Table 20 for allowable differential temperature in the concrete and ACI 306R Table 5.1 for the allowable rate of temperature change of the edges of the concrete until the outside air temperature has been reached.

3.12 DEFECTIVE CONCRETE

- .1 Concrete not meeting the requirements of the Specifications will be considered defective concrete.
- .2 Concrete not conforming to the lines, details, and grades specified herein or as shown on the Drawings shall be modified or replaced at the Contractor's expense and to the satisfaction of the Department Representative. Finished lines, dimensions, and surfaces shall be correct and true within tolerances specified herein and in Section 03100 - Concrete Formwork.

- .3 Concrete not properly placed resulting in honeycombing and other defects shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Department Representative.

3.13 REPAIR

- .1 Allow Departmental Representative to review concrete surfaces immediately upon removal of all formwork.
- .2 Remove all exposed metal form ties, nails, and wires, break off fins and remove all loose concrete.
- .3 Any imperfect joints, voids, stone pockets, or other defective areas and tie holes, as specified, shall at once be patched before the concrete is thoroughly dry. Defective areas shall be chipped away to a depth of not less than 40 mm with sawcut edges perpendicular or dovetail to the surface. The area to be repaired and a space at least 150 mm wide entirely surrounding it shall be wetted to prevent absorption of water from the repair mortar.
- .4 Cure all repairs thoroughly in accordance with Manufacturer's instructions.
- .5 Application shall conform to manufacturer's recommendations.

3.14 CONCRETE SPECIALTIES

- .1 Provide and install all concrete specialties as shown on the Drawings and as necessary to complete the concrete work.

END OF SECTION