

PART 1 - GENERAL

- 1.1 Related Work .1 Refer to other Specification Sections for related information.
- .2 Refer to **Section 01 33 00** for Shop Drawing/Submissions requirements.
- 1.2 Reference Standards .1 Canadian Standards Associations (CSA)
- .1 CSA A23.1-14 Concrete Materials and Methods of Concrete Construction
- .2 CAN/CSA-S269.3-M92 (R2003), Concrete Formwork
- 1.3 Submissions .1 Shop Drawings:
- .1 Upon request, submit to *Departmental Representative* for review four (4) sets of formwork and falsework shop drawings, in accordance with **Section 01 33 00**, at least four (4) weeks prior to erection. All such drawings to be stamped and signed by a Professional Engineer registered in the Province of Nova Scotia.
- .2 Clearly indicate method and schedule of construction, materials, arrangement of joints, ties, shores, liners, and locations of temporary embedded parts. Comply with CSA S269.1 for falsework drawings.
- .2 Product Data/Samples:
- .1 Provide product data and samples for form ties, non-shrink grout, cones and waterstops.
- .3 Provide submissions in accordance with **Section 01 33 00**.
- 1.4 Measurement for Payment .1 This item will not be measured separately.

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PART 2 - PRODUCTS

- 2.1 Materials
- .1 Formwork materials: use formwork materials to CSA A23.1-14.
  - .2 Falsework materials: to CSA S269.1
  - .3 Form release agent: non-toxic, biodegradable, low VOC, chemically active release agents containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing concrete from sticking to forms.
  - .4 Form ties: removable or snap-off metal ties, fixed or adjustable length, with conical insert 25 mm diameter in concrete surface. When forms are removed, no metal will be less than 75 mm from the surface of the concrete. Flat snap-off ties are not acceptable.
  - .5 Waterstops; Hydrophilic, 3 mm x 50 mm, 580% expansion capability in 1 day, 785% expansion capability in 4 days, 1,000 psi tensile strength.

PART 3 - EXECUTION

- 3.1 Erection
- .1 Verify lines and levels before proceeding with formwork and ensure dimensions agree with drawings.
  - .2 Construct forms to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1-14
  - .3 Line forms with material only as approved by *Departmental Representative*.
  - .4 Construct falsework in accordance with CSA S269.1

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- .5 Align form joints and make watertight. Keep form joints to minimum.
  - .6 Use 25 mm chamfer strips on external corners.
  - .7 Clean formwork in accordance with CSA A23.1, before placing concrete.
  - .8 Leave formwork in place for at least seven days, exclusive for days when temperature falls below 5°C, unless otherwise directed by *Departmental Representative*.
  - .9 Re-use of formwork and falsework subject to requirements of CSA A23.1.
  - .10 Protect hydrophilic waterstops and keep dry. Cover waterstops at end of each work day and protect during inclement weather. Replace waterstops that become wet.
  - .11 All conical holes from form ties and rods to be plugged with pre-blended, pre-bagged non-shrink grout. When forms are removed, no metal will be less than 75 mm from the surface of the concrete.



PART 1 - GENERAL

- 1.1 Related Work .1 Refer to other Specification Sections for related information.
- .2 Refer to **Section 01 33 00** for Shop Drawing/Submission requirements.
- 1.2 Reference Standards .1 American Concrete Institute (ACI)
- .1 ACI 315R-99, Details and Detailing of Concrete Reinforcement.
- .2 Canadian Standards Associations (CSA)
- .1 CSA A23.1-14 Concrete Materials and Methods of Concrete Construction
- .2 CSA A23.3-14, Design of Concrete Structures
- .3 CSA G30.3-M1983 (R1998) (or latest edition), Cold-Drawn Steel Wire for Concrete Reinforcement.
- .4 CSA G30.18 (or latest edition), Billet-Steel Bars for Concrete Reinforcement.
- .5 CSA W186-M1990 (R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .3 Reinforcing Steel Institute of Canada
- .1 Reinforcing Steel Manual of Standard Practices
- 1.3 Source Sampling .1 Upon request, provide *Departmental Representative* with certified copy of mill test of steel supplied showing physical and chemical analysis not less than 2 weeks prior to commencement of work.
- 1.4 Submissions .1 Shop Drawings:
- .1 Clearly indicate bar sizes, spacing, location and quantities of reinforcement, mesh, chairs, spacers and hangers with identifying code marks to permit correct placement without reference to structural drawings; to Reinforcing Steel Manual of Standard Practice.

- .2 Detail placement of reinforcing where special conditions occur.
- .3 Design and detail lap lengths and bar development lengths to CSA Standard A23.1, unless otherwise specified on drawings.
- .2 Product Data/Samples:
  - .1 Provide product data for supports and spacers.
- .3 Test Results:
  - .1 Provide Mill Test Certificates cross referenced to the product supplied to the site.
- .4 Provide submissions in accordance with **Section 01 33 00.**
- 1.5 Storage
  - .1 Store reinforcing steel on racks or sills that will permit easy access for identification and handling and prevent it from becoming coated with material which would adversely affect bond.
  - .2 Do not store reinforcing steel in direct contact with the ground.
- 1.6 Measurement for Payment
  - .1 This item will not be measured separately.
  - .2 Wire ties and spacers to be considered incidental to supply and placing of reinforcement.

PART 2 - PRODUCTS

- 2.1 Materials
  - .1 Reinforcing steel: to CSA G30.18; billet steel grade 400 deformed bars.
  - .2 Wire ties: to CSA G30.3 plain, cold drawn annealed steel wire.
  - .3 Spacers: PVC, Fabricated to suit site dimensions and to CSA A23.1.

- 2.2 Reinforcing Steel
- Fabrication .1 Fabricate reinforcing to CSA standard A23.1
- .2 Fabrication tolerances for reinforcing steel to Reinforcing Steel Manual of Standard Practice.
- .3 Obtain *Departmental Representative's* acceptance for locations of reinforcement splices other than shown on steel placing drawings.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar list.
- .5 Do not weld reinforcing steel.

PART 3 - EXECUTION

- 3.1 Placing .1 Accurately place reinforcing in positions indicated and hold firmly during placing, compacting and setting of concrete.
- .2 Tie reinforcement where spacing in each direction is:
- .1 Less than 300 mm: - tie at alternate intersections.
- .2 300 mm or more: - tie at each intersection.
- 3.2 Field Bending .1 Do not field bend reinforcement except where indicated or authorized by *Departmental Representative*.
- .2 When authorized, bend reinforcement without heat, by applying slow and steady pressure.
- .3 Replace bars which develop cracks or splits.
- 3.3 Cleaning .1 Clean reinforcing before placing concrete to CSA A23.1.
- 3.4 Inspection .1 Do not place concrete until *Departmental Representative* has inspected and accepted reinforcement work in place.

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- 3.5 Surface Conditions .1 Reinforcement, at time concrete is placed, to be free from mud, oil or other non-metallic coatings that adversely affect bonding capacity.
- .2 Reinforcement, with rust, mill scale, or combination of both to be considered as satisfactory, provided minimum dimensions, including height of deformations, and mass of hand wire brushed test specimen are not less than specified requirements in applicable CSA Standards.

PART 1 - GENERAL

- 1.1 Related Work .1 Refer to other Specification Sections for related information on form work and false work, concrete reinforcement, miscellaneous items.
- .2 Refer to **Section 01 33 00** for Shop Drawing/Submissions requirements.
- 1.2 Reference Standards .1 ASTM International
- .1 ASTM C260/C260M-10a, Standard Specification for Air-Entraining Admixtures for Concrete
  - .2 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds and Curing Concrete
  - .3 ASTM C494/C494M-15a, Standard Specification for Chemical Admixtures for Concrete
- .1 Canadian Standards Associations (CSA)
- .1 CSA A23.1-14 Concrete Materials and Methods of Concrete Construction
  - .2 CSA A23.2-14 Test Methods and Standard Practices for Concrete
  - .3 CSA A283-06 Qualification Code for Concrete Testing Laboratories
  - .4 CSA A3000-13 Cementitious Materials Compendium
- 1.3 Submissions .1 Shop Drawings:
- .1 Upon request, submit shop drawings and erection drawings for formwork and falsework. All such drawings to be stamped and signed by a Professional Engineer registered in the Province of Nova Scotia.
  - .2 Upon request, submit placement drawings for reinforcing steel.
  - .3 Upon request, submit placement drawings for miscellaneous items.
- .2 Product Data/Samples:

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- .1 Provide technical data and/or samples for curing compounds (winter/ summer /green /white /red), evaporation retardant and finishing aids, expansion joint materials/sealants, grouts.
  
  - .3 Certificates:
    - .1 Minimum four weeks prior to starting concrete work submit to *Departmental Representative* manufacturer's test data and certification by qualified independent inspection and testing laboratory that the following materials will meet specified requirements:
      - .1 Portland cement.
      - .2 Admixtures.
  
    - .2 Provide certification that plant, equipment, and materials to be used in concrete work comply with requirements of CSA A23.1
  
    - .3 Provide plant certification and membership certificates issued by the Atlantic Concrete Association (ACA) FOR the Ready Mix Concrete Supplier.
  
    - .4 Provide certification that mix proportions selected will produce concrete of specified quality and yield and that strength will comply with CSA A23.1
  
    - .5 Provide test results of Alkali Aggregate Reactivity (AAR) of the proposed aggregate sources and proportion the concrete mixture to prevent excessive expansion due to AAR.
  
  - .4 Methodology:
    - .1 Submit methodology for cold weather concreting.
    - .2 Submit methodology for hot weather concreting.

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- .3 Submit methodology for concrete placement operations.
  - .4 Submit methodology for supporting reinforcing steel.
  - .5 Test Results:
    - .1 Provide design mix tests results.
    - .2 Provide mill test certificates for reinforcing steel.
  - 1.4 Storage of Materials
    - .1 Store all materials to prevent contamination or deterioration, whether at the plant or at the job site.
    - .2 Store cement in watertight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment whether at the plant or at the job site.
    - .3 Prevent stored liquid admixtures and compounds from freezing and powdered admixtures and compounds from absorbing moisture.
  - 1.5 Source Sampling
    - .1 At least 4 weeks prior to commencing work, inform *Departmental Representative* of proposed source of aggregates and provide access for sampling.
  - 1.6 Ready-Mix Concrete Supply
    - .1 Provide, with each load of concrete delivered to site, duplicate delivery slips containing following:
      1. Name of ready-mix batch plant.
      2. Serial number of ticket.
      3. Date and truck number.
      4. Project identification.
      5. Class of concrete or mix.
      6. Amount of concrete in cubic metres.
      7. Time of loading or first mixing of aggregate, cement and water.
      8. Time of discharge of concrete.
      9. Admixtures added at plant.
      10. Amount of water added at plant.
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- 1.7 Measurement for Payment
- .1 Heating of water and aggregates and providing cold weather protection will not be measured but considered incidental to work.
  - .2 Cooling of concrete and providing hot weather protection will not be measured but considered incidental to work.
  - .3 Supply of anchor bolts, washers and nuts will not be measured but considered incidental to work. Bolt grouting will be considered incidental to the work.
  - .4 Supply and installation of rigid PVC sleeves, waterstops, expansion joints/sealants and curing compounds, or other compounds will be considered incidental to the work.
  - .5 Concrete work will be measured in accordance with Section 01 29 00.

PART 2 - PRODUCTS

- 2.1 Materials
- .1 Aggregates: to CSA A23.1-14. Coarse aggregates to be normal density.
  - .2 Portland Cement: to CSA A3001-13
  - .3 Supplementary Cementing Materials: to CSA A3001
  - .3 Water: to CSA A23.1
  - .4 Admixtures:
    - .1 Air entraining admixtures: to ASTM C260/260M
    - .2 Chemical admixtures: to and ASTM C494/C494M

- .5 Non-shrink grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents, of pouring consistency, capable of developing compressive strength of 50 MPa at 28 days.
  - .6 Curing compound: To ASTM-C309-11 and CSA A23.1 (or latest editions) type 1, 1D, or 2.
- 2.2 Concrete Mixes
- .1 Prior to starting concrete work, submit to the *Departmental Representative* the proposed mix design(s) for approval. Mix design(s) are to be proportioned in accordance with Alternative 1 of Table 5 in CSA A23.1-14 (or latest edition).
    - .1 Fishway Baffles, Fishway Exit Walls and Fishway Guide Wall Repair
      - .1 Use concrete mix designed to produce air entrained concrete meeting the following requirements:
      - .2 Cement: Type GU to CSA A3001-13
      - .3 Supplementary Cementing Materials to CSA A3001-13
      - .4 Class of Exposure: Class C-1.
      - .5 Minimum compressive strength at 28 days: 35 MPA.
      - .6 Maximum nominal aggregate size: 20 mm.
      - .7 Proportion mixture to prevent excessive expansion due to alkali aggregate reactivity.
      - .8 Air content: 5 to 8%.
      - .9 Maximum water/cement ratio to be 0.40.
      - .10 Slump at time and point of discharge, by use of superplasticizer, 125 mm +/- 25 mm. Where the nature of the work requires larger slumps, they are to be obtained by the use of

admixtures rather than increasing the water content. The use of such admixtures and the increase in slump to be approved by the *Departmental Representative* prior to implementation in the work.

- .11 Modify concrete mix to the approval of the *Departmental Representative* to accommodate pumping.
- .12 Admixtures to the approval of the *Departmental Representative* and the recommendation of the manufacturer. Admixtures must be dispersed separately into mixing water.

.2 Diversion / Training Wall Repair

- .1 Use concrete mix designed to produce air entrained concrete meeting the following requirements:
  - .2 Cement: Type GU to CSA A3001-13
  - .3 Supplementary Cementing Materials to CSA A3001-13
  - .4 Class of Exposure: Class C-1.
  - .5 Minimum compressive strength at 28 days: 35 MPA.
  - .6 Maximum nominal aggregate size: 10 mm
  - .7 Proportion mixture to prevent excessive expansion due to alkali aggregate reactivity.
  - .8 Air content: 7 to 9%.
  - .9 Maximum water/cement ratio to be 0.40.
- .10 Slump at time and point of discharge, by use of superplasticizer, 180 mm +/- 30 mm. Where the nature of the work requires larger slumps, they are to be obtained by the use of admixtures rather than increasing the water content.

- .11 Modify concrete mix to the approval of the *Departmental Representative* to accommodate pumping.
- .12 Admixtures to the approval of the *Departmental Representative* and the recommendation of the manufacturer. Admixtures must be dispersed separately into mixing water.
- .2 Do not use calcium chloride or compounds containing calcium chloride.
- .3 Weigh aggregates, cement, water and admixtures separately when batching. Inspect and test scales for accuracy as directed. Accuracy to be such that successive quantities can be measured to within one percent of desired amounts. Test certificates to be submitted to *Departmental Representative* upon request.
- .4 Where seven day strength is less than 70% of specified 28 day strength, provide additional protection curing and make changes to mix proportions to the satisfaction of the *Departmental Representative*.
- .5 Provide certification that plant, equipment and all materials to be used in concrete comply with the requirements of CSA A23.1-14 (or latest edition).
- .6 Provide certification from independent testing and inspection company that mix proportions selected will produce concrete of specified quality and can be effectively placed and finished for all work under this contract.

PART 3 - EXECUTION

- 3.1 General .1 Obtain *Departmental Representative's* approval before placing concrete. Provide 24 hours notice of intended placement.
- .2 Place, consolidate, finish, cure and protect concrete to CSA A23.1-14 (or latest edition) except where specified otherwise.
- .3 Prior to placing of concrete, obtain *Departmental Representative's* approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .4 Do not commence placing concrete until *Departmental Representative* has inspected/reviewed forms, inserts, waterstops, dowels, reinforcing steel, joints; conveying, spreading, consolidation, finishing, curing and protective methods.
- .5 Ensure that reinforcement and anchorage are not disturbed during placing.
- .6 Maintain accurate records of placed concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .8 Do not place load(s) upon new concrete until *Departmental Representative* is satisfied that the Contractor has carried out all calculations and tests necessary to confirm that the load(s) will not cause damage or create a safety hazard. Calculations and tests to be stamped by a Professional Engineer registered in the Province of Nova Scotia.
- 3.2 Reinforcing Steel .1 Place new reinforcing steel according to **Section 03 20 00.**

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- .2 Provide 75 mm minimum cover for all reinforcing steel unless indicated otherwise on drawings.
- 3.3 Formwork
- .1 Verify field dimensions to determine applicable sizes of formwork.
- .2 Design and construct form work to allow adequately for proper placement and consolidation while conforming with shape and dimensions shown on plans.
- .3 Formwork design will include closures at both top and bottom of form, and all necessary hardware to support the forms.
- .4 Upon request, submit drawings for review by the *Departmental Representative*, at least 3 weeks before placement of concrete. Drawings, will show formwork details and illustrate dimensions, method of placing of concrete, connections and support.
- .5 Strip formwork after minimum 5 days. This condition might be waived only if an alternative method to curing and preventing alternate wetting and drying is provided, to the satisfaction of the *Departmental Representative*. This condition will be waived if the forms are left permanently in place, where approved by the *Departmental Representative*.
- 3.4 Placement of Concrete
- .1 Place and consolidate concrete to CSA A23.1-14 (or latest edition).
- .2 If allowed by *Departmental Representative*, pump concrete to following requirements:
- .1 Arrange equipment so that no vibrations result which might damage freshly placed concrete.
- .2 Where concrete is conveyed and placed by mechanically applied pressure, provide suitable equipment.

- .3 Operate pump so that concrete, without air pockets, is produced.
  - .4 When pumping is discontinued and concrete remaining in pipe line is to be used, void pipe line in a manner that prevents contamination of concrete or separation of ingredients. Do not allow fresh concrete to enter the waterway.
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- .3 Concrete will be deposited in all cases as neatly as practicable, directly in its final position, and will not be caused to flow in a manner to permit or cause segregation.
  - .4 Each layer of concrete will be vibrated and tamped with an appropriate vibrator as allowed by the *Departmental Representative*. The concrete must be compacted to the maximum practicable density, free of air pockets, and until it is in complete contact with the reinforcement and formwork.
- 3.5 Inserts
- .1 Set galvanized sleeves and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 X 100 mm not indicated on drawings must be approved by *Departmental Representative*.
  - .2 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of all modifications from *Departmental Representative* before placing of concrete.
  - .3 Galvanized items embedded in concrete will be completely separated from reinforcing steel.
  - .4 Anchor bolts:
    - .1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

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- 3.6 Protection and Curing
- .1 Provide protection and curing in accordance with CSA A23.1
  - .2 Protect concrete with windproof shelter to allow free circulation of inside air around fresh concrete. Do not let walls of shelter touch formwork and provide sufficient space for removal of formwork.
  - .3 Supply approved heating equipment to maintain inside air at following temperatures:
    - .1 For an initial three days, at not less than 10° C nor more than 25° C at surfaces.
    - .2 At not less than 10° C for an additional 4 consecutive days or for the time necessary to attain 70% of the specified 28-day compressive strength of the concrete.
    - .3 Reduce temperature near end of curing period at rate not exceeding 20° C per day.
    - .4 Do not overheat.
  - .4 Keep concrete surfaces continuously moist during protection stage and allow concrete to dry before removal of protection.
  - .5 Freshly deposited concrete will be protected from premature drying and excessively hot and cold temperatures, will be maintained without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete. It will be protected from harmful effects of sunshine, drying winds, cold weather, running or surface water and mechanical shock.
- 3.7 Finishing
- .1 Finish concrete in accordance with CSA A23.1-14 (or latest edition).

- .2 Grind off fins, nibs and other raised protuberances with an approved hand stone.
- .3 When concrete has hardened sufficiently, give slab surface a uniform finish free from porous spots, irregularities, depressions, small pockets or rough spots using a bull float leaving a semi-smooth, uniform textured non-slip surface.
- .4 Following use of bull float, provide fine broom finish using steel wire or stiff, coarse, fibre broom. Use broom in a transverse ridges satisfactory to *Departmental Representative*. Brooming will be delayed until concrete is sufficiently hard to retain ridges.
- .5 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radius edges unless otherwise detailed.

3.9 Field

Quality Control

- .1 Inspection and testing of concrete and concrete materials will be carried out by Testing Laboratory designated by the *Departmental Representative* in accordance with CSA A23.1-14 (or latest edition).
- .2 *Departmental Representative* will pay for costs of tests as specified in **Section 01 45 00**.
- .3 *Departmental Representative* will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .4 If tests do not meet requirements of the *Departmental Representative*, take such measures as indicated in CSA A23.1-14 and CSA A23.2-14 (or latest editions).

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- .5 Arrange and pay for inspection and testing when necessary for production control to meet requirements.
  - .6 Inspection and testing by *Departmental Representative* will not augment Contractor's quality control or relieve him of contractual responsibility.
- 3.10 Defective Work
- .1 Concrete is defective when:
    - .1 failing to meet any requirement of this specification
    - .2 concrete contains honeycombing or embedded debris
    - .3 28-day strength in any area is less than 95% of specified minimum.
  - .2 Repair or remove and replace defective work as directed by the *Departmental Representative*.
  - .3 Take corrective measures as directed by the *Departmental Representative* to prevent occurrence of further defective concrete.