

PART 1 - GENERAL

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|------------------------------------|----|---|
| 1.1 <u>Related Work</u>            | .1 | Refer to other Specification Sections for related information.  |
|                                    | .2 | Refer to Section 01 33 00 for Shop Drawing/ Submissions requirements.   |
| 1.2 <u>Reference Standards</u>     | .1 | CSA A23.1/A23.2-19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.   |
|                                    | .2 | CSA S269.1-21, Falsework and Formwork.  |
| 1.3 <u>Submissions</u>             | .1 | Shop Drawings: <ul style="list-style-type: none"><li>.1    Upon request, submit to the Departmental Representative formwork and falsework shop drawings, in accordance with Section 01 33 00, at least 14 calendar days prior to erection.</li><li>.2    All such drawings to be stamped and signed by a professional engineer registered in the Province of Nova Scotia.</li><li>.3    Clearly indicate method and schedule of construction, materials, arrangement of joints, ties, shores, liners, and locations of temporary embedded parts.</li><li>.4    Comply with CSA S269.1 for falsework drawings.</li></ul> |
|                                    | .2 | Product Data/Samples: <ul style="list-style-type: none"><li>.1    Provide product data and samples for form ties.</li></ul>   |
|                                    | .3 | Provide submissions in accordance with Section 01 33 00.  |
| 1.4 <u>Measurement for Payment</u> | .1 | This item will not be measured separately but will be considered incidental to the Work in accordance with Section 01 29 00 - Project Particulars and Measurement.  |

## PART 2 - PRODUCTS

### 2.1 Materials

- .1 Formwork lumber: plywood and wood formwork materials to CSA A23.1.
- .2 Falsework materials: to CSA S269.1.
- .3 Form release agent: 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, free of devices leaving holes larger than 25 mm diameter in concrete surface. When forms are removed, no metal will be less than 50 mm from the surface of the concrete.

## 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
- .3 Line forms with material only as approved by the Departmental Representative.
- .4 Construct falsework in accordance with CSA S269.1.
- .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 (7) days, exclusive for days when temperature falls below 5 degrees Celsius, unless otherwise directed by the Departmental Representative.

- .9 Re-use of formwork and falsework subject to requirements of CSA A23.1.
- .10 All holes from form ties and rods to be plugged with mortar to requirements of CSA A23.1. When forms are removed, no metal will be less than 25 mm from the surface of the concrete.

### 3.2 Falsework and Formwork.1

- Design and construct formwork and falsework to resist severe exposed wave conditions.
- .2 Submit formwork and falsework design to the Departmental Representative for review prior to construction.
- .3 Formwork and falsework design to be approved by a professional engineer registered in the Province of Nova Scotia.

**END OF SECTION**

PART 1 - GENERAL

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|-----|--------------------------------|----|--|
| 1.1 | <u>Related Work</u>            | .1 | Refer to other Sections for related information.   |
|     |                                | .2 | Refer to Section 01 33 00 for Shop Drawing/<br>Submission requirements.  |
| 1.2 | <u>Reference<br/>Standards</u> | .1 | CSA A23.1/A23.2-19, Concrete Materials and<br>Methods of Concrete Construction.  |
|     |                                | .2 | Reinforcing Steel Manual of Standard Practice<br>(latest edition) by Reinforcing Steel Institute<br>of Ontario.  |
|     |                                | .3 | CSA G30.18-19, Carbon Steel Bars for Concrete<br>Reinforcement.  |
|     |                                | .4 | ASTM A1064/A1064M-18A, Standard Specification for<br>Carbon-Steel Wire and Welded Wire Reinforcement,<br>Plain and Deformed, for Concrete.   |
| 1.3 | <u>Source Sampling</u>         | .1 | Upon request, provide Departmental Representative<br>with certified copy of mill test of steel<br>supplied showing physical and chemical analysis<br>not less than two (2) weeks prior to commencement<br>of work.   |
| 1.4 | <u>Submissions</u>             | .1 | Shop Drawings:<br>.1 Clearly indicate bar sizes, spacing,<br>location and quantities of reinforcement<br>and mesh with identifying code marks to<br>permit correct placement without reference<br>to structural drawings; to Reinforcing<br>Steel Manual of Standard Practice.<br>.2 Detail placement of reinforcing where<br>special conditions occur.<br>.3 Design and detail lap lengths and bar<br>development lengths to CSA standard A23.1,<br>unless otherwise specified on drawings. |
|     |                                | .2 | Product Data/Samples:<br>.1 Provide product data for supports and<br>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 but will be considered incidental to the Work in accordance with Section 01 29 00 - Project Particulars and Measurement.

PART 2 - PRODUCTS

2.1 Materials

.1 Reinforcing steel: to CSA G30.18; billet steel grade 400 deformed bars.

.2 Wire ties: to ASTM A1064 plain, cold drawn annealed steel wire.

.3 Spacers: PVC, fabricated to suit site dimensions.

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 the 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 the 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.
- 3.4 Inspection
- .1 Do not place concrete until the Departmental Representative has inspected and accepted reinforcement work in place.
- 3.5 Surface Conditions
- .1 Reinforcement, at time concrete is placed, to be free from mud, oil or other nonmetallic 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.

**END OF SECTION**

PART 1 - GENERAL

- 1.1 Related Work
- .1 Refer to other Specification Sections for related information on aggregates, formwork and falsework, concrete reinforcement, miscellaneous items.
  - .2 Refer to Section 01 33 00 for Shop Drawing/ Submissions requirements.
- 1.2 Reference Standards
- .1 Do structural concrete work in accordance with CSA A23.1/A23.2-19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete, except where more stringent standards specify otherwise.
  - .2 ACI 318-19, Building Code Requirements for Structural Concrete and Commentary on Building Code Requirements for Structural Concrete.
  - .3 ASTM C309-19, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
  - .4 ASTM C494/C494M-19, Standard Specification for Chemical Admixtures for Concrete.
  - .5 ASTM C881/C881M-20A, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
  - .6 ASTM F593-17, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
  - .7 CSA A3000-18, Cementitious Materials Compendium.
- 1.3 Submissions
- .1 Shop Drawings:
    - .1 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 Submit placement drawings for reinforcing steel.
    - .3 Submit placement drawings for miscellaneous items.
  - .2 Product Data/Samples:
    - .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.
- .2 Submit concrete mix design.
- .3 Certificates:
  - .1 Minimum four (4) weeks prior to starting concrete work submit to the 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 certification that mix proportions selected will produce concrete of specified quality, yield, and strength and will comply with CSA A23.1.
  - .4 Minimum two (2) weeks prior to commencing concrete work, submit a concrete mix design stamped by an engineer licensed to practice in the Province of Nova Scotia, to the Departmental Representative for review containing the following for each concrete mix:
    - .1 Cement type.
    - .2 Minimum compressive strength and age as per class of exposure.
    - .3 Class of exposure.
    - .4 Nominal size of coarse aggregate.
    - .5 Air content.
    - .6 Slump at time and point of discharge.
    - .7 Minimum and maximum times to placement from initial mixing.
  - .5 Provide certification that only compatible components and non-reactive aggregate will be used in the concrete mix designs. Use of admixtures to neutralize or mitigate potential alkali-aggregate reactivity (AAR) will not be accepted.
- .4 Methodology and Quality Control:
  - .1 Submit for review methodology and quality control procedures for the following:
    - .1 Cold weather concreting.
    - .2 Hot weather concreting.



- .3 Concrete placement operations, including underwater concreting. Provide details of pour sequence and proposed layout of construction joints.
    - .4 Concrete finishing operations.
    - .5 Supporting reinforcing steel.
    - .6 Protection and curing of concrete in cold and hot weather.
  - .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 three (3) weeks prior to commencing work, inform the 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.

- 1.7 Measurement for Payment
- .1 Heating of water, aggregates and concrete and providing cold weather protection will not be measured but will be considered incidental to the work.
  - .2 Cooling of concrete and providing hot weather protection will not be measured but will be considered incidental to the work.
  - .3 Supply of anchor bolts, washers and nuts shall not be measured but will be considered incidental to the work.
  - .4 Bolt grouting will not be measured but will be considered incidental to the work.
  - .5 Supply and installation of curing compounds and other compounds will be considered incidental to the work.
  - .6 Cast-in-place concrete will be measured in accordance with the item to which applies in Section 01 29 00 - Project Particulars and Measurement.

## PART 2 - PRODUCTS

- 2.1 Materials
- .1 Aggregates: to CSA A23.1.
  - .2 Portland Cement and supplementary cementing materials: to CSA A3000.
  - .3 Water: to CSA A23.1.
  - .4 Admixtures:
    - .1 Air entraining admixtures: to CSA A3000.
    - .2 Chemical admixtures: to CSA A3000 and ASTM C494.
    - .3 Pozzolanic mineral admixtures: to CSA A3000.
  - .5 Non-shrink grout: premixed compound consisting of non-metallic aggregate, Portland cement, additives, suitable for underwater marine and vertical applications, capable of developing compressive strength of 40 MPa at 28 days.

- .6 Curing compound: To ASTM C309 and CSA A23.1 type 1, ID, or 2.
- .7 Adhesive Anchors: Two component, tube injected system conforming to ASTM C881/C881M, Types I, II, IV, and V, Grade 3, Class B, and C. Adhesive to be tested in accordance with the ICC-ES acceptance criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308). Technical data to be published in an ICC-ES Evaluation Service Report showing compliance with ACI 318 and/or CSA A23.3. Installation of adhesive anchors, including drilling of holes, preparation, storage, usage and curing to be in accordance with the manufacturer's written instructions.
  - .1 Acceptable products:
    - .1 Hilti HIT-RE 500 V3, as manufactured by Hilti (Canada) Corporation.
    - .2 Purell10+ as manufactured by Dewalt Industrial Tool Co.
    - .3 Epcon C6+, as manufactured by ITW Red Head.
- .8 Anchor bolts (rods): to ASTM F593 (AISI Type 316 stainless steel), unless noted otherwise.
- .9 Bonding Agent/Corrosion Inhibitor: fresh concrete to existing concrete bonding agent and corrosion inhibitor coating for existing reinforcing steel.
  - .1 Acceptable products:
    - .1 Duralprep A.C. as manufactured by the Euclid Chemical Company.
    - .2 MasterEmaco P124 as manufactured by BASF Corporation.
    - .3 SikaTop Armatec - 110 EpoCem as manufactured by Sika Canada.

## 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) to be in accordance with Alternative 1 of Table 5 in CSA A23.1. Comply with additional requirements of CSA A23.1, clause 4.1.1.5 for concrete exposed to sea water or sea water spray.
  - .1 For concrete in general wharf construction and slabs on grade use concrete mix designed to produce air entrained concrete meeting the following requirements:
    - .1 Cement: to CSA A23.1.

- .2 Minimum compressive strength at 28 days: 35 MPa.
- .3 Exposure: Class C-1 and S-3.
- .4 Nominal size of coarse aggregate: 20mm.
- .5 Minimum cement content 390 kg/m<sup>3</sup>.
- .6 Air content: 5 to 8%.
- .7 Maximum water/cement ratio to be 0.40.
- .8 Use admixture(s) to provide shrinkage compensating characteristics. Have admixtures approved by the Departmental Representative prior to implementation in the Work.
- .9 Slump at time and point of discharge 80 mm ± 20 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. Use of such admixtures and the increase in slump to be approved by the Departmental Representative prior to implementation in the work.
- .10 Provide anti-washout admixtures where concrete will be placed and/or cured underwater.
- .2 For tremie concrete use concrete mix designed to produce air entrained concrete meeting the following requirements:
  - .1 Cement: to CSA A23.1.
  - .2 Minimum compressive strength at 28 days: 35 MPa.
  - .3 Exposure: Class C-1 and S-3.
  - .4 Nominal size of coarse aggregate: 10mm or 20mm, to suit placement equipment/method.
  - .5 Minimum cement content 390 kg/m<sup>3</sup>.
  - .6 Air content: 5 to 8%.
  - .7 Maximum water/cement ratio to be 0.40.
  - .8 Use admixture(s) to provide anti-washout and shrinkage compensating characteristics. Have admixtures approved by the Departmental Representative prior to implementation in the Work.
  - .9 Slump at time and point of discharge 80mm ± 20mm. 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. Use of such admixtures

and the increase in slump to be approved by the Departmental Representative prior to implementation in the work.

- .3 Modify concrete mix to the approval of the Departmental Representative to accommodate pumping.
- .4 Admixtures to the approval of the Departmental Representative and the recommendation of the manufacturer. Admixtures must be dispersed separately into mixing water.
- .5 Do not use calcium chloride or compounds containing calcium chloride.
- .6 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 the Departmental Representative upon request.
- .7 Where 7-day strength is less than 70% of specified 28-day strength, provide additional protection and curing, and make changes to mix proportions to the satisfaction of the Departmental Representative.
- .8 Provide certification that plant, equipment, and all materials to be used in concrete comply with the requirements of CSA A23.1.
- .9 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.
- .10 Use plasticizer to increase slump and workability.

### PART 3 - EXECUTION

#### 3.1 General

- .1 Obtain the Departmental Representative's approval before placing concrete. Provide 48 hours notice of intended placement. Place concrete in dry form condition.

- .2 Place, consolidate, finish, cure and protect concrete to CSA A23.1 except where specified otherwise.
- .3 Prior to placing of concrete, obtain the Departmental Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .4 Comply with additional requirements of CSA A23.1 except where specified otherwise, for concrete exposed to seawater environment.
- .5 Do not commence placing concrete until the Departmental Representative has inspected/reviewed forms, inserts, dowels, reinforcing steel, joints, conveying, consolidation and protective methods.
- .6 Do not disturb reinforcement and anchorage during placing.
- .7 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 the 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.
- .9 Comply with additional requirements of CSA A23.1, for concrete exposed to seawater environments during placement and curing.
- .10 Location of construction joints and sequence of placing to be determined by professional engineer registered in the Province of Nova Scotia and submitted to Departmental Representative for review prior to commencing construction.

### 3.2 Reinforcing

- .1 Place new reinforcing steel according to Section 03 20 00.
- .2 Provide 75 mm minimum cover for all reinforcing steel unless indicated otherwise on drawings.

- .3 All existing reinforcing steel that has lost bond with the concrete or has more than one-half of its circumference exposed is to be undercut by at least 25mm.
- .4 All exposed existing reinforcing steel must be free of all loose scale, rust, and other contaminants.
- .5 Apply corrosion inhibitor to all exposed existing reinforcing steel.

### 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 to 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 seven (7) 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. Concrete to be placed in dry form condition (when possible), by coordinating pour with low tide.
- .2 Place concrete in areas that are completely clean, free from water, ice, debris, and all unsuitable materials. Permit the Departmental

Representative to review the prepared substrate prior to placement of concrete.

- .3 Apply bonding agent to concrete surfaces prior to placement of fresh concrete.
- .4 Do not begin placement of concrete until minimum time from initial mixing specified in the reviewed concrete mix design has elapsed.
- .5 Place all concrete within 1.5 hours of initial mixing. If 1.5 hours is insufficient, provide a set retarder sufficient in quantity to allow for proper placement.
- .6 If allowed by the 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 pipeline is to be used, void pipeline in a manner that prevents contamination of concrete or separation of ingredients.
- .7 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.
- .8 Vibrate and tamp each layer of concrete 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.
- .9 Do not use concrete with a temperature less than 10°C or greater than 30°C at the time of delivery or placement.

### 3.5 Inserts

- .1 Set galvanized sleeves and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 x 100mm not



indicated on the structural drawings must be approved by the 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 the Departmental Representative before placing of concrete.
- .3 Any galvanized items embedded in concrete shall be completely separated from reinforcing steel.
- .4 Anchor bolts:
  - .1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
  - .2 With Departmental Representative's agreement, grout anchor bolts in pre-formed holes or holes drilled after concrete has set. Formed holes to be at least 100mm in diameter. Drilled and epoxied or grouted holes to be minimum 25mm larger in diameter than bolts used, unless indicated otherwise by manufacturer's recommendations.
  - .3 Protect anchor bolt holes from water accumulations.
  - .4 Set bolts and fill holes with non-shrink grout.

### 3.6 Finishing

- .1 Finish concrete in accordance with CSA A23.1.
- .2 Grind off fins, nibs and other raised protuberances with an approved hand stone.
- .3 When concrete has hardened sufficiently, give deck surface a uniform finish free from porous spots, irregularities, depressions, small pockets, or rough spots.
- .4 On exterior slabs provide coarse broom finish using steel wire or stiff, coarse, fibre broom. Use broom in a transverse ridge 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.

3.7 Protection and  
Curing

- .1 Provide protection and curing in accordance with CSA A23.1.
- .2 Protect concrete with windproof shelter(s) to allow free circulation of inside air around fresh concrete. Do not let walls of shelter touch formwork. Provide sufficient space in shelters for removal of formwork.
- .3 Keep concrete surfaces continuously moist during concrete curing and protection stage and allow concrete to dry gradually before removal of protection.
- .4 Protect freshly deposited concrete from premature drying and excessively hot and cold temperatures and maintain concrete without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete. Protect freshly deposited concrete from the harmful effects of sunshine, drying winds, cold and hot weather, running or surface water, mechanical shock, vandalism, etc.
- .5 When the air temperature is at or below 10°C or when there is a probability of falling below 10°C within 24 hours of placing, as forecast by the nearest official meteorological office, keep all materials and equipment needed for adequate protection and curing during cold weather on hand and ready for use before concrete placement is started. Extent of such preparation to be in accordance with the requirements of CSA A23.1 and to the approval of the Departmental Representative.
- .6 When placing concrete during cold weather, adequate protection of concrete shall be provided for the duration of the curing and protection period as defined in CSA A23.1. Protection shall be provided by means of heated enclosures, coverings, insulation, or a suitable combination of these methods.
- .7 Enclosures:
  - .1 Construct to withstand wind and snow loads.
  - .2 Make reasonably airtight.

- .3 Housing to provide sufficient space between the concrete and the enclosure to permit free circulation of warmed air.
- .4 Supply heat to the enclosure by live steam, forced hot air, stationary heaters, or other heaters of various types. Exhaust fumes from enclosures so there is no build-up of exhaust fumes within heated enclosures.
- .8 Take extreme care with curing methods during cold or hot weather concreting and shall supply approved equipment in order to maintain inside air within the following temperatures.
  - .1 For initial three (3) consecutive days at not less than 10°C and not more than 25°C, at surfaces.
  - .2 Wet cure concrete for additional four (4) consecutive days at not less than 10°C and not more than 35°C for the time necessary to attain 70% of the specified strength.
  - .3 Maintain temperature of concrete as close as possible to suggested minimum temperature of 10°C during the curing period.
  - .4 If using silica fume in concrete, use additional curing procedures and extend cure time, as necessary.
  - .5 Reduce temperature near end of curing period at rate not exceeding 20°C per day.
  - .6 No salt or other chemical shall be used to lower the freezing point of the concrete as a substitute for the specific curing and protection.
  - .7 Do not overheat concrete.

3.8 Field Quality  
Control

- .1 Arrange and pay for inspection and testing of concrete and concrete materials by Testing Laboratory in accordance with CSA A23.1 and as specified in Section 01 41 00.
- .2 Departmental Representative will pay for Quality Assurance costs of tests as specified in Section 01 41 00.
- .3 Test cylinders:
  - .1 For compressive testing of concrete a minimum of 4-100mm x 200mm cylinders are required for:
    - .1 Each day's pour.

- .2 Each mix design change.
- .3 Each change of supplier.
- .4 Each 20 cubic meters.
- .2 Take additional 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 and CSA A23.2. Additional testing required due to defective materials or failed test shall be at Contractor's cost.
- .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.

### 3.9 Defective Work

- .1 Concrete is defective when:
  - .1 It fails to meet any requirement of this specification.
  - .2 The concrete contains honeycombing or embedded debris.
  - .3 The 28-day strength in any area is less than 95% of specified minimum.
  - .4 Concrete test results fail any other aspect/test of CSA A23.1.
- .2 If concrete is found to not meet these specifications or code requirements, repair or remove and replace defective work as directed by Departmental Representative, at no additional cost to the Contract.
- .3 If necessary, take corrective measures as directed by the Departmental Representative to prevent the occurrence of further defective concrete.

**END OF SECTION**

PART 1 - GENERAL

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|-----|----------------------------|----|---|
| 1.1 | <u>Related Sections</u>    | .1 | Section 03 30 00 - Cast-in-Place Concrete   |
| 1.2 | <u>Reference Standards</u> | .1 | CSA A23.1/A23.2-19, Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete.   |
| 1.3 | <u>Definitions</u>         | .1 | Tremie concrete is placed underwater through a tube called a tremie pipe. Tremie pipe has a hopper at upper end and may be open ended or may have a foot valve, plug or travelling plug to control flow of concrete. Concrete is placed in hopper and a sufficient head of concrete is maintained in tremie pipe to provide desired rate of flow. |
|     |                            | .2 | Pumped concrete method of placing concrete underwater uses a concrete pump with a discharge line used in a similar manner to a tremie pipe.   |

PART 2 - PRODUCTS

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|-----|-----------------------|----|---|
| 2.1 | <u>Concrete Mixes</u> | .1 | Concrete mixes: to Section 03 30 00 - Cast-in-Place Concrete. |
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PART 3 - EXECUTION

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|-----|--------------------|----|--|
| 3.1 | <u>General</u>     | .1 | Do concrete work in accordance with CSA A23.1.   |
| 3.2 | <u>Preparation</u> | .1 | Notify the Departmental Representative at least 48 hours in advance of intention to commence underwater work.  |
|     |                    | .2 | Place concrete in one continuous operation to full depth required. Provide sufficient supply of concrete to complete pour without interruption and supply complete equipment for every phase of operation. |
|     |                    | .3 | Where concrete must bond to existing surfaces, clean surfaces just prior to starting concrete  |

placement. Use water jets, mechanical scraper or other means.

### 3.3 Tremie Method

- .1 Provide tremie pipe which is watertight and sufficiently large to allow free flow of concrete. Diameter of tremie pipe to be not less than 200mm or less than eight times maximum size of coarse aggregate.
- .2 Provide hopper at top of tremie pipe and means to raise and lower tremie.
- .3 Provide plug or foot valve at end of tremie pipe to permit filling pipe with concrete initially.
- .4 Start pour with tremie pipe full of concrete and keep end of pipe buried in freshly placed concrete at least 300 mm. Control rate of flow by increasing or decreasing depth of end in concrete.
- .5 If seal is lost, allowing water to enter pipe, withdraw pipe immediately.
- .6 If tremie operation is interrupted so that a horizontal construction joint must be made, cut surface laitance by jetting, within 24 to 36 hours and remove loose material by pumping or air lifting before placing next lift.
- .7 Do not place concrete in flowing water. Do not vibrate, disturb, or puddle concrete after it has been placed.

### 3.4 Pumped Concrete Method

- .1 Follow procedures as for tremie method in placing concrete using discharge line from concrete pump as tremie pipe.

**END OF SECTION**