
PART 1 - GENERAL

- 1.1 Related Sections
- .1 Concrete Reinforcing: Section 03 20 00
 - .2 Concrete: Section 03 30 00
- 1.2 References
- .1 Canadian Standards Association (CSA International)
 - .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA 086-14, Consolidation - Engineering Design in Wood.
 - .3 CSA 0121-08(R2013), Douglas Fir Plywood.
 - .4 CSA 0153-M1980(R2013), Poplar Plywood.
 - .5 CSA 0437 Series-93(R2011), Standards for OSB and Waferboard.
 - .6 CAN/CSA-S269.1-16, Falsework and Formwork.
 - .2 CAN/ULC S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- 1.3 Submittals
- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Submit shop drawings for formwork and falsework.
 - .3 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CAN/CSA-S269.1 for formwork drawings.
 - .4 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
 - .5 Indicate sequence of erection and removal of formwork/falsework as directed by Departmental Representative.
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- 1.4 Delivery, Storage and Handling
- .1 Waste Management and Disposal:
- .1 Place materials defined as hazardous or toxic in designated containers.
- .2 Divert wood materials from landfill to a recycling facility as approved by Departmental Representative.
- .3 Divert plastic materials from landfill to a recycling facility as approved by Departmental Representative.
- .4 Divert unused form release material from landfill to an official hazardous material collections site as approved by the Departmental Representative.

PART 2 - PRODUCTS

- 2.1 Materials
- .1 Formwork materials:
- .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA 0121, CSA 086, CSA 0437 Series, CSA 0153.
- .2 Rigid insulation board: to CAN/ULC S701.
- .2 Form release agent: non-toxic and biodegradable.

PART 3 - EXECUTION

- 3.1 Fabrication and Erection
- .1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Obtain Departmental Representative's approval for use of earth forms framing openings not indicated on drawings.
- .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .4 Fabricate and erect falsework in accordance with Shop Drawings reviewed by the Departmental Representative.

- .5 Do not place shores and mud sills on frozen ground.
 - .6 Provide site drainage to prevent washout of soil supporting mud sills and shores.
 - .7 Fabricate and erect formwork in accordance with CAN/CSA S269.1 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.
 - .8 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
 - .9 Use 25 mm chamfer strips on external corners.
 - .10 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
 - .11 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
 - .12 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.
 - .13 Leave formwork in place for at least 7 (seven) days, exclusive for days when temperature falls below 5°C, unless otherwise directed by Departmental Representative.
 - .14 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
 - .15 Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.
 - .16 All holes from form ties and rods to be plugged with mortar to requirements of CSA A23.1/A23.2. When forms are removed, no metal will be less than 25 mm from the surface of the concrete.
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PART 1 - GENERAL

- 1.1 Related Sections
- .1 Submittal Procedures: Section 01 33 00
 - .2 Cleaning: Section 01 74 00
 - .3 Concrete Forming and Accessories: Section 03 10 00
 - .4 Concrete: Section 03 30 00
- 1.2 References
- .1 American Concrete Institute (ACI):
 - .1 ACI SS-66-04, ACI Detailing Manual.
 - .2 AASHTO M32M/M32-09(R2013), Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - .3 ASTM A123/A123M-15, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .4 ASTM A143/A143M-07(R2014), Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .5 ASTM A1064/A1064M-15, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - .6 Canadian Standards Association (CSA):
 - .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA A23.3-14, Design of Concrete Structures.
 - .3 CSA G30.18-09(R2014), Carbon Steel Bars for Concrete Reinforcement.
 - .4 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CSA W186-M1990(R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.
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- .7 Reinforcing Steel Institute of Canada (RSIC)
.1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.3 Submittals

 - .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and SP-66.
 - .3 Shop Drawings:
 - .1 Submit drawings indicating:
 - .1 Placing of reinforcement.
 - .2 Bar bending details.
 - .3 Lists.
 - .4 Quantities of reinforcement.
 - .5 Sizes, spacings, locations of reinforcement.
 - .6 Indicate sizes, spacings and locations of chairs, spacers and hangers.
 - .2 Detail lap lengths and bar development lengths to CAN/CSA A23.3.

1.4 Quality Assurance

 - .1 Submit in accordance with Section 01 45 00 - Testing Laboratory Services.
 - .1 Mill Test Report: upon request, provide Departmental Representative with certified copy of mill test report of reinforcing steel, minimum two (2) weeks prior to beginning reinforcing work.
 - .2 Upon request submit in writing to Departmental Representative proposed source of reinforcement material to be supplied.

1.5 Delivery, Storage and Handling

 - .1 Deliver, store and handle materials in accordance with regulatory requirements.
 - .2 Storage and Handling Requirements:
 - .1 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 Materials

- .1 Substitute different size bars only if permitted in writing by Departmental Representative.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CSA G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CSA G30.18.
- .4 Cold-drawn annealed steel wire ties: to AASHTO M32.
- .5 Welded steel wire fabric: to ASTM A1064/A1064M.
 - .1 Provide in flat sheets only.
- .6 Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.
- .7 Mechanical splices: subject to approval of Departmental Representative.
- .8 Plain round bars: to CSA G40.20/G40.21.

2.2 Fabrication

- .1 Fabricate reinforcing steel in accordance with CSA A23.1/A23.2, SP-66, and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain the Departmental Representative's written approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of the Departmental Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

- 2.3 Source Quality Control
- .1 Upon request, provide the Departmental Representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum two (2) weeks prior to beginning reinforcing work.
 - .2 Upon request inform the Departmental Representative of proposed source of material to be supplied.

PART 3 - EXECUTION

- 3.1 Field Bending
- .1 Do not field bend or field weld reinforcement except where indicated or authorized by Departmental Representative.
 - .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
 - .3 Replace bars, which develop cracks or splits.
- 3.2 Placing Reinforcement
- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA A23.1/A23.2.
 - .2 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with one (1) coat of asphalt paint.
 - .2 When paint is dry, apply thick even film of mineral lubricating grease.
 - .3 Prior to placing concrete, obtain the Departmental Representative's approval of reinforcing material and placement.
 - .4 Maintain cover to reinforcement during concrete pour.
- 3.3 Cleaning
- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
 - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.
- .4 Place materials defined as hazardous or toxic in designated containers.

Part 1 - General

- 1.1 Related Sections
- .1 Submittal Procedures: Section 01 33 00
 - .2 Health and Safety Requirements: Section 01 35 29
 - .3 Quality Control: Section 01 45 00
 - .4 Concrete Forming and Accessories: Section 03 10 00
 - .5 Concrete Reinforcing: Section 03 20 00
 - .6 Underwater Concreting: Section 03 37 26
- 1.2 References
- .1 ACI-211.1-91(R2009), Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - .2 ASTM C260-10a, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .3 ASTM C457-2012, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.
 - .4 ASTM C494-2015A, Standard Specification for Chemical Admixtures for Concrete.
 - .5 ASTM C1202-2012, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
 - .6 ASTM D1751-2011, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .7 ASTM D5971-13, Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material.
 - .8 ASTM D6023-15, Standard Test Method for Density (Unit Weight), Yield, Cement Content and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).

- .9 ASTM STP1331-EB(1998), The Design and Application of Controlled Low-Strength Materials (Flowable Fill).
- .10 CAN/CGSB 51.34-M86 AMEND, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .11 Canadian Standards Association (CSA International):
 - .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA A283-06(R2011), Qualification Code for Concrete Testing Laboratories.
 - .3 CSA A3000-2013, Cementitious Materials Compendium.
- 1.3 Abbreviations and Acronyms
 - .1 Cement: hydraulic cement or blended hydraulic cement (XXb - where b denotes blended).
 - .1 Type GU or GUb - General use cement.
 - .2 Type MS or MSb - Moderate sulphate-resistant cement.
 - .3 Type MH or MHb - Moderate heat of hydration cement.
 - .4 Type HE or Heb - High early-strength cement.
 - .5 Type LH or LHb - Low heat of hydration cement.
 - .6 Type HS or HSb - High sulphate-resistant cement.
 - .2 Fly ash:
 - .1 Type F - with CaO content less than 8%.
 - .2 Type CI - with CaO content ranging from 8 to 20%.
 - .3 Type CH - with CaO greater than 20%.
 - .3 GGBFS - Ground, granulated blast-furnace slag.
- 1.4 Submittals
 - .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Submit copies of WHMIS MSDS, Material Safety Data Sheets.

- .3 Submit copies of mix designs.
 - .4 Submit pour sequence for concrete fill.
- 1.5 Quality Assurance
 - .1 Quality Assurance: in accordance with Section 01 45 00.
 - .2 Provide the Departmental Representative, minimum four (4) weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.
 - .1 When plant does not hold valid certification, provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet specified requirements.
 - .3 Minimum four (4) weeks prior to starting concrete work, provide proposed quality control procedures for review by the Departmental Representative on following items:
 - .1 Falsework erection.
 - .2 Hot weather concrete.
 - .3 Cold weather concrete.
 - .4 Curing.
 - .5 Finishes.
 - .6 Formwork removal.
 - .7 Joints.
 - .4 Health and Safety Requirements: Do construction occupational health and safety requirements in accordance with Section 01 35 29.
- 1.6 Delivery, Storage and Handling
 - .1 Delivery and Acceptance Requirements:
 - .1 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.
 - .1 Do not modify maximum time limit without receipt of prior written agreement from Owner's Representative and concrete producer as described in CSA A23.1/A23.2.
 - .2 Submit deviations for review by the Departmental Representative.

.2 Concrete delivery: confirm continuous concrete delivery from plant meets CSA A23.1/A23.2.

PART 2 - PRODUCTS

2.1 Materials

- .1 Cement: to CSA A3000, Type GU.
- .2 Water: to CSA A23.1.
- .3 Aggregates: to CSA A23.1/A23.2.
- .4 Admixtures:
 - .1 Air entraining admixture: to ASTM C260.
 - .2 Chemical admixture: to ASTM C494.
Departmental Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .5 Curing compound: to CSA A23.1/A23.2 white, Type 1-chlorinated rubber.
- .6 Premoulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751.
 - .2 Sponge rubber: to ASTM D1752, Type I, firm grade.
- .7 Non-shrink grout: pre-mixed 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.
- .8 Controlled Low-Strength Material (CLSM) to be a self-compacting, cementitious backfill material with a flowable consistency.
- .9 Adhesive anchors: high strength two-part epoxy adhesive. To requirements of ASTM C881, type IV, Grade 2 and 3. Anchor rods to ASTM A193, Grade B7, high strength carbon steel.

2.2 Mixes

- .1 Confirm materials used in concrete mix have been submitted for testing and meet the requirements of CSA A23.1.
- .2 Co-ordinate construction methods to suit Departmental Representative concrete mix proportions and parameters.
- .3 Identify and report immediately to Departmental Representative when concrete mix design and parameters pose anticipated problems or deficiencies related to construction.
- .4 Proportion normal density concrete in accordance with CAN/CSA A23.1, Alternative 1 to give the following properties for cast-in-place concrete, pre-cast concrete panels and light standard bases:
 - .1 Cement to be normal Portland cement, Type GU.
 - .2 Minimum compressive strength at 28 days: 35MPa.
 - .3 Class of exposure: C-1.
 - .4 Maximum aggregate size to CSA A23.1 Table 11, Group 1, 20 mm size.
 - .5 Minimum cement content 390 kg/m³.
 - .6 Air content: 5 to 8%.
 - .7 Maximum water/cement ratio to be 0.40.
 - .8 Slump at time and point of discharge 80mm ±20mm. Where 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.
- .5 Proportion normal density concrete in accordance with CAN/CSA A23.1, Alternative 1 to give the following properties for concrete fill above water:
 - .1 Cement type: GU.
 - .2 Minimum compressive strength at 28 days: 20 MPa.
 - .3 Maximum aggregate size to CSA A23.1 Table 11, Group 1, 20 mm size.
 - .4 Slump at time and point of discharge: 80mm ±20mm. Where 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.

- .6 Maintain a minimum of 600 mm separation between horizontal control joints and pre-cast panel joints.
- .7 Refer to Section 03 37 26 Underwater Concreting for concrete fill below water.
- .8 Be responsible for the mix design and quality control of concrete production.
- .9 The Departmental Representative will review and approve mix designs and provide quality assurance with regard to concrete testing. All concrete mix design proportioning including the mix quality control operations must be performed by a Laboratory CCIL or CSA Certified in accordance with CSA A283. Conduct testing as stated in CAN/CSA A23.1 and A23.2. The proposed mixture design must be signed by a Professional engineer registered to practice in the Province of Prince Edward Island. The Professional engineer will attest to the validity of the material test data. Proposed mix designs and test results are only considered valid for up to two (2) years in advance of the date of the project mix design submission.
- .10 Also include with each mix design submission the following necessary information:
 - .1 Project number and title description.
 - .2 Contractor company name with contact information.
 - .3 Ready mix supplier.
 - .4 Certifying laboratory with signing engineer.
 - .5 Type of concrete, intended use, approximate quantity and method of placement.
 - .6 Mix slump and air entraining agent range plus all admixtures with dosage rates.

- .11 Do not place concrete until approval of the mix design has been obtained from the Departmental Representative. Submit copies of the concrete mix design 14 days in advance of any concrete placement operation.
- .12 Once approved, no adjustments will be made to the concrete mix design without the approval of the Departmental Representative. If material characteristics change after the original mix design approval submit a revised mix design for approval.
- .13 Acceptance by the Departmental Representative of the Contractor's concrete mix design does not relieve the Contractor of the responsibility for providing concrete which meets the specifications.
- .14 High range water reducing agents (superplasticizers) may be used at the Contractor's request, if so indicated when the mix design is submitted. The Contractor must demonstrate competence and experience in their use and specific approval must be obtained. State method of concrete placement when submitting concrete mix design.
- .15 If superplasticizers are used, the maximum concrete slump in a super plasticized condition shall be limited to 230 mm. The mix design must state the design slump before and after the addition of superplasticizers along with the appropriate tolerances. Note that the slump in the above table may not be applicable when using superplasticizers.
- .16 Samples for concrete testing quality assurance purposes will normally be taken from concrete as delivered to the site (at the point of discharge from the delivery equipment). However, depending on the method of placement, random sampling of the concrete as incorporated into the structure may also be performed to verify the above specified properties. This process entails the sampling of fresh concrete as close to the point of deposit in the structure as is practicable. Coring of the in-place hardened concrete may

also be performed to verify the specified air void system. The Departmental Representative reserves the right to designate the point of acceptance, with prior notice given to the Contractor.

- .17 Modify concrete mix to the approval of the Departmental Representative to accommodate pumping.
- .18 Admixtures to the approval of the Departmental Representative and the recommendation of the manufacturer. Admixtures must be dispersed separately into mixing water.
- .19 Do not use calcium chloride or compounds containing calcium chloride.
- .20 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.
- .21 Where seven 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.
- .22 Provide certification that plant, equipment and all materials to be used in concrete comply with the requirements of CSA A23.1.
- .23 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.

2.3 CONTROLLED LOW-
STRENGTH MATERIAL (CLSM)

- .1 Proportion CLSM mix design of Portland cement, flyash, compatible non-alkali aggregate reactive materials and water to suit a late-age compressive strength of 1.0MPa.

PART 3 - EXECUTION

3.1 Preparation

- .1 Obtain the Departmental Representative's written approval before placing concrete.
 - .1 Provide 48 hours minimum notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .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 Departmental Representative has inspected/reviewed forms, inserts, dowels, reinforcing steel, joints, anchorage, conveying, consolidation and protective methods.
- .6 Pumping of concrete will not be permitted without approval by Departmental Representative.
- .7 Do not disturb reinforcement and inserts during concrete placement.
- .8 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.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 In cold weather protect concrete work to CSA A23.1 and the following:

.1 Cold weather is defined as a period when the mean air temperature drops below 5°C for more than three (3) successive days.

.2 When air temperature is above 0°C and is forecast to remain so for 48 hours after placing, insulated tarps are acceptable protection provided concrete temperatures are monitored and comply with temperature limits specified in the following paragraph.

.3 For all other cold weather conditions protect concrete with a windproof enclosure of canvas or other material to allow free circulation of inside air around fresh concrete. At no point let walls of enclosure touch formwork and provide sufficient space for removal of formwork and for finishing. Supply approved heating equipment capable of keeping inside air at sufficient space for removal of formwork and for finishing. Supply approved heating equipment capable of keeping inside air at sufficient curing temperatures.

.1 For an initial three days, at a temperature of not less than 15°C.

.2 Maintain concrete at temperatures of not less than 10°C for a total period of seven days plus the initial three days specified above.

.3 At no time shall concrete temperatures exceed 30°C at surfaces.

.4 Reduce enclosure air temperature at a rate not exceeding 10°C per day until outside air temperature has been reached.

.5 Take temperature readings both of air and of concrete surfaces at several points within areas protected at start and at end of working day. Maintain complete records of temperature readings.

.4 Confirm concrete cures without suffering damage. When enclosure is provided, avoid rapid drying of the concrete.

.11 In hot weather with prior approval from the Departmental Representative protect concrete work to CSA A23.1 and following:

.1 When air temperature is at or above 25°C, do not use curing compounds and keep concrete surfaces moist continually during protection stage using burlap maintained in a moist condition.

- .2 Regulate the generation of heat through hydration to control thermal gradients to prevent thermal cracking.
 - .12 Do not place load upon new concrete until authorized by the Departmental Representative.
 - .13 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
 - .1 Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.
 - .14 Apply bonding agent to all existing concrete surfaces in accordance with manufacturer's instructions prior to the placement of new concrete.
- 3.2 Installation/
Application
 - .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
 - .2 Sleeves and inserts:
 - .1 Where approved by the Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .2 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by the Departmental Representative.
 - .3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Departmental Representative before placing of concrete.
 - .4 Confirm locations and sizes of sleeves and openings shown on drawings.
 - .5 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
 - .3 Anchor bolts:
 - .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.

- .2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Departmental Representative.
 - .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
 - .4 Set bolts and fill holes with epoxy grout.
 - .5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.
 - .4 Grout under base plates where required using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.
 - .5 Finishing and curing:
 - .1 Finish concrete to CSA A23.1/A23.2.
 - .2 Use procedures as reviewed by Owner's Representative or those noted in CSA A23.1/A23.2 to remove excess bleed water. Do not damage surface.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces.
 - .6 Joint fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by the Departmental Representative.
 - .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
 - .3 Install joint filler.
- 3.3 Surface Tolerance
 - .1 Concrete tolerance to CSA A23.1.
- 3.4 Field Quality Control
 - .1 Site tests: conduct QUALITY CONTROL tests as follows in accordance with Section 01 45 00 for:
 - .1 Concrete pours.
 - .2 Slump.
 - .3 Air content.
 - .4 Compressive strength at 7 and 28 days (samples).

- .2 Carry out inspection and testing of concrete and concrete materials by testing laboratory approved by the Departmental Representative for review to CSA A23.1/A23.2.
 - .1 Use testing laboratory certified to CSA A283.
- .3 Owner will pay for costs of tests.
- .4 Additional test cylinders to be taken during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .5 Inspection or testing by Owner will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

3.5 Cleaning

- .1 Clean in accordance with Section 01 74 00.
 - .2 Waste Management: separate waste materials for reuse and recycling.
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PART 1 - GENERAL

1.1 Reference Standards

- .1 Do Concrete work in accordance with CSA standard A23.1-14, Concrete Materials and Methods of Concrete Construction, except where stricter standards specify otherwise.
- .2 Do testing for concrete in accordance with CSA standard A23.2-14, Methods of Test for Concrete, except where stricter standards specify otherwise.
- .3 CAN/CSA A3000-13, Cementitious materials compendium.
- .4 ASTM C494-15A, Chemical Admixtures for Concrete

1.2 Definitions

- .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.

1.3 Samples

- .1 Submit shop drawings in accordance with Section 01 33 00
- .2 Shop drawings shall clearly indicate the size and location of existing voids and the procedures for filling and restraining the pumped concrete. All materials shall be clearly identified on these drawings.

1.4 Certificates

- .1 Minimum two (2) 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
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following materials will meet specified requirements:

- .1 Cement Type GU
- .2 Admixtures
- .3 Aggregates
- .4 Water

- .2 Provide certification that plant, equipment and materials to be used in concrete comply with requirements of CSA standard A23.1
- .3 Provide certification that mix proportions selected will produce concrete of specified quality, yield, strength, and will comply with CSA standard A23.1

1.5 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 Name or number of project.
 - .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 that discharge of concrete begins and ends.
 - .9 Type and quantity of admixtures added at plant.
 - .10. Quantity of water added at plant.

1.6 Measurement
For Payment

- .1 This item will be measured in accordance with Section 01 29 00, Project Particulars and Measurement.
- .2 Underwater concrete placed by the tremie pipe method or the pumped concrete method will not be measured as a separate item. Refer to Section 01 29 00 for basis of payment.
- .3 Underwater Concrete: Removal of silt, soft material and debris as specified will be considered incidental to the work and no separate payment will be made.

PART 2 - PRODUCTS

- 2.1 Materials
- .1 Concrete materials: to Section 03 30 00, Cast-in-Place Concrete.
 - .2 Reinforcing Steel: Comply with Section 03 20 00.
- 2.2 Concrete Mixes
- .1 For underwater concrete:
 - .1 Cement type: GU.
 - .2 Minimum compressive strength at 28 days: 20 MPa.
 - .3 Class of exposure: C-1.
 - .4 Nominal size of coarse aggregate: 20mm, or as approved by Departmental Representative.
 - .5 Fine aggregate content: 42 to 45% of total aggregate mass.
 - .6 Slump at point and time of submergence discharge: 140 to 200mm.
- 2.3 Admixtures
- 1. Admixtures will be subject to approval of Departmental Representative. Admixtures will only be permitted to correct deficiencies in mix or to improve placement of concrete.
 - 2. Departmental Representative may withdraw prior approval of admixture if conditions encountered during course of work indicate unsatisfactory performance.
 - 3. Do not use calcium chloride or materials containing calcium chloride.

PART 3 - EXECUTION

- 3.1 General
- .1 Do concrete work in accordance with CSA standard A23.1
- 3.2 Preparation
- .1 Notify Departmental Representative at least 48 hours in advance of intention to commence underwater work.
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- .2 Prior to placement of pumped concrete, remove silt, soft material, organic material and debris from the area. Use high pressure water jets or an airhose.
- .3 Place concrete in one continuous operation to full depth required, except as may be indicated on drawings, related to maximum "lift" height. Provide sufficient supply of concrete to complete pour without interruption and supply complete equipment for every phase of operation.
- .4 Where concrete must bond to existing surfaces, clean surfaces just prior to concrete placement. Use water jets, mechanical scrapers and other means to remove marine growth, deteriorated concrete and rust scale on metal surfaces.

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 200 mm 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 Provide minimum of two (2) tremie pipes for every 9m² of pour plan area or maximum of 3 m centre to centre. Do not move tremie pipes laterally by dragging through concrete.
 - .5 Start pour with tremie pipe full of concrete and keep end of pipe buried in freshly placed concrete at least 300 m. Control rate of flow by increasing or decreasing depth of end in concrete.
 - .6 If seal is lost, allowing water to enter pipe, withdraw pipe immediately.
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.7 If tremie operation is interrupted so that a horizontal construction joint has to be made, cut surface laitance by jetting, within 24 to 36 h and remove loose material by pumping or air lifting before placing next lift.

.8 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.

.2 Pump discharge line to have minimum diameter approved by Departmental Representative.