This specification outlines the requirements for supply and placement of concrete underwater by tremie, pumped concrete, bottom dump bucket, or bagged concrete method.

PART 1 REFERENCES

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

CSA Group

A23.1/A23.2	Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
A3000	Cementations Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005)

PART 2 GENERAL

2.1 DEFINITIONS

.1 Tremie concrete is placed underwater through a tube called a tremie pipe.

.2 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. Pipe has diameter of 200 mm minimum, constructed from sections with flange couplings fitted with gaskets.

.1 Concrete is placed in hopper and a sufficient head of concrete is maintained in tremie pipe to provide desired rate of flow.

.3 Pumped concrete method of placing concrete underwater uses a concrete pump with a discharge line used in a similar manner to a tremie pipe.

.4 Bottom-dump bucket method of placing concrete underwater requires use of a bucket designed to discharge from bottom after it has contacted foundation or surface of previous placed concrete.

.5 Bagged concrete method of placing underwater concrete consists of a diver placing bags partially filled with concrete mix.

2.2 ADMINISTRATIVE REQUIREMENTS

.1 Concrete pre-placement meeting; conduct pre-placement meeting five (5) business days minimum before tremie operation.

.1 Ensure meeting includes as minimum attendees as follows:

.1 General contractor.
.2 Ready-mix concrete supplier.
.3 Admixture supplier.
.4 Placing/formwork sub-contractor.
.5 Reinforcing sub-contractor.
.6 Testing agency representative.
.7 Structural engineer.
.8 Owner's Representative.

.2 Distribute to attendees copies of concrete mix designs, aggregate physical properties, placing schedule, rate of delivery, testing program, and contingency plan for delay and breakdown.

2.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01340 – Shop Drawings, Samples and Submissions.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for concrete and include product characteristics, performance criteria, physical size, finish and limitations.

2.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01600~~015~~ – Material and Equipment and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect concrete from nicks, scratches, and blemishes.
.3 Replace defective or damaged materials with new.

PART 3 PRODUCTS

3.1 MATERIALS

.1 Material requirements for production of concrete shall be in accordance with Section 03300 – Cast-in-Place Concrete, except as specified otherwise herein.

.2 Type GU Portland cement in accordance with CSA A3000, unless otherwise specified.

.3 For placing bagged concrete, use bags made of coarsely woven material to allow concrete to bond between bags.

3.2 CONCRETE MIXES

.1 Use 42 to 45 % fine aggregate by weight in concrete mix for workability.

.2 Use not less than 385 kg/m^3 of cement.

.3 Air Content 4-7 %

.4 For tremie concrete, produce a mix with a slump of 190 ± 40 mm and a water cement ratio of not more than 0.45.

.5 For pumped concrete and bottom-dump bucket concrete produce a mix with a slump and fill bags to not more than 0.45.

.6 For bagged concrete, thoroughly mix a very dry mix concrete of zero (0) to 25 mm maximum slump and fill bags to not more than 80 % full just before placing.

.7 Produce concrete with a minimum compressive strength of 25 MPa at 28 calendar days unless otherwise specified.

3.3 ADMIXTURES

.1 Admixtures will be subject to approval of the Owner. Admixtures will only be permitted to correct deficiencies in mix or to improve placement of concrete.

.2 Owner 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.

.4 Submit admixtures to produce self-consolidating calcium chloride to Owner for review.

PART 4 EXECUTION

4.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for concrete placement installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of the Owner.
.2 Inform the Owner of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Owner.

4.2 PREPARATION

.1 Where concrete must bond to existing concrete surfaces, rock surfaces, piling, sheet piling or anchor rods, clean thoroughly just prior to starting concrete placement.

.1 Use water jets and when quantities of silt or mud or rock cuttings are present, remove by air lift.

4.3 INSTALLATION

.1 Do concrete work in accordance with Sections 03300 Cast-in-Place Concrete and 03200 – Concrete Reinforcement, CSA A23.1/A23.2 and as specified herein. Testing for concrete to CSA A23.1/A23.2.

.2 Where concrete placement extends above water surface, protect concrete from direct contact with air at temperature below 5 ° C for Owner's specified number of days.

.3 Place concrete in one continuous operation to full depth required.

.1 Provide sufficient supply of concrete to complete pour without interruption and supply complete equipment for every phase of operation.

.4 Tremie method

.1 To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie tube or other approved method. Still water shall be maintained at the point of deposit and the forms underwater shall be watertight. Precautions shall be taken to prevent the loss of concrete by washing action of the water.
.2 No concrete shall be spread at any greater distance than 3 m from the discharge end of the tremie tube. When large areas are to be covered tremie tubes at maximum 6 m centres shall be used and concrete placed simultaneously.
.3 If the tremie operation is unavoidably interrupted below water level, the surface laitance shall be removed by jetting one day after placing and removed by pumping.

.4 Provide a tremie pipe that is watertight and sufficiently large to allow free flow of concrete. Diameter of tremie pipe to be minimum 200 mm and minimum eight (8) times maximum size of coarse aggregate, constructed in sections having flanged couplings fitted with gaskets and must be watertight.

.5 Provide a hopper at top of tremie pipe and means to raise and lower tremie.

.6 Provide plug or foot valve at end of tremie pipe to permit filling pipe with concrete initially.

.7 Provide a minimum of one tremie pipe for every 30 m^2 of pour plan area and to maximum spacing of 6 m centre to centre. Do not move tremie pipes laterally by dragging through concrete.

.8 Start pour with tremie pipe full of concrete and keep bottom of pipe buried in freshly placed concrete at least 300 mm. Control rate of flow by increasing or decreasing depth of end in concrete.

.9 If seal is lost, allowing water to enter pipe, withdraw pipe immediately. Refill pipe and continue placing as specified.

.10 If tremie operation is interrupted so that a horizontal construction joint has to 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.

.11 Do not place concrete in flowing water when current exceeds 3 m/min. Do not vibrate, disturb or puddle concrete after it has been placed.

.5 Pumped Concrete Method

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

.6 Bottom-Dump Bucket Method

.1 Completely fill bucket with concrete, cover top surface and lower slowly through water to prevent backwash.

.2 Discharge concrete only when bucket is in contact with surface on which concrete is to be deposited.

.3 Withdraw bucket slowly until it is well above concrete to maintain as nearly as possible still water at point of discharge to approval of the Owner.

.4 Do not place concrete in flowing water when current exceeds 3 m/min.

.7 Bagged Concrete Method

.1 Use bags made of coarsely woven material to allow concrete to bond between bags.

.2 Fill bags not more that 80 % full before placing.

.3 Place each concrete bag individually so that bag is stable and securely resting on foundation material or previously placed bags.

4.4 UNDERWATER VIDEO AND/OR PHOTO INSPECTION

.1 Underwater video and/or photo inspection as per Section 02704 – Sanitary Sewer Outfall Pipe.

4.5 SAMPLING AND TESTING

.1 The Contractor shall co-operate fully with the Owner's Representative in enabling quality assurance tests to be carried out. Samples for quality testing 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 shall also be performed to verify the above specified properties. This process shall entail 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 Department reserves the right to designate the point of acceptance, with prior notice given to the Contractor.

.2 Field quality assurance testing will be carried out by an Owner's Representative in accordance with CSA A23.2.

.3 Quality assurance tests carried out by the Department shall conform to the following guidelines:

.1 Air & Slum Tests: Each load until 5 consecutive batches meet the requirements then test every third load thereafter.

.2 Strength & Temperature Tests: At least 1 set of Laboratory cylinders per 100 cubic metres, minimum 1 set per day plus 1 set of field cures per category of concrete if required by the Owner's Representative.

.3 Additional strength tests will be required when early indications of strength are required such as before prestressing, girder transport, removal of falsework, backfilling structure, etc.

.4 If either the measured slump, air content or temperature fall outside the limits specified, a repeat test shall be made. Failure to meet the contract requirements shall result in rejection of the concrete. Acceptance of the concrete will depend on the results and consistency of all of the above test's results being satisfactory.

4.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01710 – Reinstatement and Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01710 – Reinstatement and Cleaning

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 5 PAYMENT

5.1 MEASUREMENT FOR PAYMENT

.1 Concrete placed underwater will be measured in cubic metres to specified pay limits unless otherwise specified.

.2 In accordance with subsection 5.1.22.2.1 of this specification pay limits may be up to theoretical volume plus 10 %, as verified.

.3 Underwater Video and/or Photo Inspection will be measured by lump sum.

5.2 BASIS OF PAYMENT

.1 All costs associated with the work outlined in this specification shall be deemed to be included in the appropriate unit and lump sum prices quoted as outlined in the Measurement for Payment subsection of this specification and as included in the MERX Schedule of Quantities and Prices.