

CAST-IN-PLACE REINFORCED CONCRETE

1. GENERAL

1.1 Work Included

- .1 Supply and installation of cast-in-place reinforced concrete filter underdrain.
 - .1 Filter underdrain design and Drawings, and supply of hardware are part of the Supply Contractor's scope of work under Bid Opportunity 427-2005, and in Specification Section 11004- Filter Underdrains Installation.
 - .2 Setting anchors, inserts, sleeves and pier forms, and other items supplied by Supply Contractor.
 - .3 Finishing formed concrete surfaces.
 - .4 Curing of concrete.

1.2 Quality Assurance

- .1 Cast-in-place reinforced concrete shall conform to CAN/CSA A23.1-04.
- .2 Testing shall conform to CAN/CSA A23.2-04.
- .3 These standards shall be available in the Contractor's Site office for the use of the Contractor, sub-trades, and Contract Administrator.
- .4 A concrete pour release form shall be completed prior to each concrete pour. The Contractor shall be responsible for completing the forms. Each form shall be signed by the Contractor and Contract Administrator prior to each pour.

1.3 Performance Requirements

- .1 28-day Concrete Compressive Strength
 - .1 Normal-density concrete: 35 MPa, containing reinforcing bars, Class of exposure C-1, as required by the Supply Contractor, and in accordance with CAN/CSA-23.1-04.
 - .2 Density
 - .1 Normal density $2350 \pm 50 \text{ kg/m}^3$.
 - .3 Construction Tolerances
 - .1 Comply with CAN/CSA A23.1-04, Clause 6.4, unless noted otherwise.

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1.4 Submittals

- .1 Concrete Mix Design
 1. Submit proposed performance mix, and supplier's applicable standard deviations to the Contract Administrator for review minimum two (2) weeks prior to commencement of the Work. Pay costs for all mix design. Indicate range of cementing materials content, type of cement, size of coarse aggregate, water/cementing material ratio, admixtures used, air content and slump.
 2. Submit detailed plan for cold weather curing and protection of concrete placed and cured in weather below 5°C.
 - .3 Submit detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 27°C.
 - .4 Concrete mix designs will be reviewed for conformance with requirements of the Specifications and will be returned with Contract Administrator's comments.

1.5 Inspection & Testing

- .1 Notify the Contract Administrator at least forty eight (48) hours before complete formwork and concrete reinforcement are ready for review. Concrete sampling, inspection, and testing is to be performed by a CSA certified inspection and testing firm appointed and paid for by the City.
- .2 Provide unencumbered access to all portions of Work and cooperate with appointed firm.
- .3 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.
- .4 Notify the Contract Administrator at least twenty four (24) hours in advance of any concrete placement. Under no circumstances shall concrete be placed without notifying Contract Administrator.
- .5 At least three (3) concrete test cylinders will be taken for every twenty (20) or less cubic metres of concrete placed.
- .6 At least three (3) test cylinders will be taken daily.
- .7 One (1) slump test and one (1) air content test will be taken for each set of test cylinders taken.
- .8 Additional slump and air content tests may be taken as necessary (up to every truck) to verify quality of concrete at the discretion of the Contract Administrator.
- .9 Testing of concrete shall be performed in accordance with CAN/CSA A23.2-04. Test results will be issued to the Contractor, the Contract Administrator, and the City.

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- .10 The Contractor shall pay costs for required retesting due to defective materials or workmanship.
- .11 If accepted by the Contract Administrator, the Contractor may arrange and pay for additional tests for use as evidence to expedite construction.
- .12 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When three (3) or more tests of the same type of concrete are available, the average of any three (3) consecutive tests shall be equal to, or greater than the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. If any of the criteria of the above clause are not met, the Contract Administrator shall have the right to require one or more of the following:
 - .1 Changes in mix proportions for the remainder of the Work.
 - .2 The changes in the mix proportions shall be at the Contractor's expense.
 - .3 Concrete failing to meet the strength requirements of this Specification shall be replaced at the Contractor's expense.

2. PRODUCTS

2.1 General

- .1 All materials that will come in contact with potable water shall meet the requirements of National Sanitary Foundation (NSF) 60/61.

2.2 Concrete Materials

- .1 Cement: Type GU Portland Cement conforming to CAN/CSA A3001-03.
- .2 Fine Aggregate: Size in accordance with the Supply Contractor requirements, conforming to Normal-Density Fine Aggregate, CAN/CSA A23.1-04. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to Normal-Density Fine Aggregate, CAN/CSA A23.1-04, Table 10.
- .3 Coarse Aggregate: Size in accordance with the Supply Contractor requirements, conforming to Group I, CAN/CSA A23.1-04. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to Normal-Density Coarse Aggregate, CAN/CSA A23.1-04, Table 11. Group II may be used for special requirements such as gap grading, pumping, or for blending two (2) or more sizes to produce Group I gradings.
- .4 Ensure that no aggregates are used that may undergo volume change due to alkali reactivity, moisture retention, or other causes. Confirm suitability of aggregate with a petrographic analysis if deemed necessary by the Contract Administrator.

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- .5 Water: Potable, clean, and free from injurious amounts of oil, alkali, organic matter, or other deleterious matter.
- .6 Materials are to be obtained from the same source of supply or Manufacturer for the duration of the project.
- .7 Pozzolans: Type F fly ash, conforming to CAN/CSA A3001-03; source of material to be acceptable to the Contract Administrator. Maximum allowable substitution of cement with fly ash material shall be 10% by weight if accepted by the Supply Contractor, and when acceptable to the Contract Administrator.

2.3 Admixtures

- .1 No admixtures other than air-entraining agent, water-reducing agent, and superplasticizer shall be used without the written authorization of the Contract Administrator, unless specified.
- .2 Air entrainment: conforming to American Society for Testing and Materials (ASTM) Standard C260.
- .3 Water-reducing agent: Type WN conforming to ASTM Standard C494.
- .4 Superplasticizer: conforming to ASTM Standard C494.
- .5 General Chemical Admixtures: conforming to ASTM Standard C494.
- .6 Calcium chloride or admixtures containing calcium chloride shall not be used in concrete.

2.4 Accessories

- .1 Curing Sealer: sodium silicate, Miracle Kote or accepted alternate.
- .2 Moisture Retention Film: Master Builders Confilm or accepted alternate.

2.5 Concrete Mixes

- .1 Pay all costs for mix design. Submit mix design to the Contract Administrator for review a minimum of two (2) weeks prior to concrete pour.
- .2 Provide concrete mixed in accordance with requirements of CAN/CSA A23.1-04, and as required by the Supply Contractor. The more stringent requirements shall govern where there is a difference between the Supply Contractor's requirements and the requirements of CAN/CSA A23.1-04.
- .3 Use accelerating admixtures in cold weather only when accepted by the Contract Administrator. If accepted, the use of admixtures will not relax cold weather placement requirements. Do not use calcium chloride.

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- .4 Use set-retarding admixtures during hot weather only when accepted by the Contract Administrator.
- .5 All admixtures must be compatible within the mix. Concrete with freezing and thawing exposure must satisfy the durability requirements of CAN/CSA A23.1-04, Section 7.4.
- .6 All admixtures are subject to acceptance by the Contract Administrator. List all proposed admixtures in mix design submission. Do not change or add admixtures to accepted design mixes without the Contract Administrator's review and acceptance.
- .7 The water: cementing ratio must be calculated and shown based on all available mixing water excluding aggregate absorption.
- .8 Concrete delivered to Site must be accompanied by a delivery slip indicating time of completion of mixing, design strength of concrete, air content, and actual water-cement ratio.
- .9 Materials are to be obtained from the same source of supply or Manufacturer for the duration of the project.
- .10 Self-compacting concrete mixes will not be permitted for use on this project.

2.6 Reinforcement

- .1 Reinforcing Materials
 - .1 Reinforcing steel: 400R and 400W as shown on the Supply Contractor's Drawings; deformed billet steel bars conforming to CAN/CSA G30.18-M92(R2002); plain finish.
- .2 Accessory Materials
 - .1 Tie wire: minimum 1.6 mm annealed type, or patented system accepted by Contract Administrator.
 - .2 Plastic underdrain form, chairs, inserts, underdrain supports: Supplied by Supply Contractor

3. EXECUTION

3.1 Placing Concrete

- .1 Place concrete in accordance with requirements of CAN/CSA A23.1-04 and as indicated on the Supply Contractor's Drawings. Completely place concrete for the filter underdrain within one filter cell without interruption of placement. Layout of the Work and accuracy of same is the Contractor's sole responsibility.
- .2 All concrete shall be placed within 90 minutes of mixing. The concrete shall be placed rapidly and evenly to its final position without re-handling and flowing by methods

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ensuring to minimize the risk of segregation, loss of ingredients, and cold joints. Under no circumstances shall the concrete, which has partially hardened, be deposited in the forms.

- .3 Ensure all anchors, inserts, and other items to be cast into concrete are securely placed and will not interfere with concrete placement.
- .4 All equipment for transporting the concrete shall be cleaned of hardened concrete and foreign materials before placing concrete.
- .5 Immediately before concrete is placed, Contractor shall carefully inspect all supports to ensure that they are properly placed and sufficiently rigid, and that all reinforcing steel and embedded parts are in the correct position and secured against movement during the placing operation. All supports shall be thoroughly cleaned and all debris removed.
- .6 Concrete shall be thoroughly compacted by mechanical vibrators during placing operations. It shall be thoroughly worked around the reinforcement, embedded items, and into the corners of the forms. Vibrators shall not be used to move concrete.
- .7 Vibrate concrete using the appropriate size equipment as placing proceeds, in accordance with CAN/CSA A23.1-04. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure.
- .8 In locations where new concrete is dowelled to existing concrete, follow requirements and instructions of the Supply Contractor.
- .9 Where placing operations would involve dropping the concrete more than 1500 mm, it shall be placed through canvas hoses or galvanized iron chutes. Concrete shall not be raised at a rate greater than that for which proper vibration may be affected.
- .10 Do not place concrete if carbon dioxide producing equipment has been in operation in the building or in the enclosure during the twelve (12) hours preceding the pour. This equipment shall not be used during placing or for twenty four (24) hours after placing. During placing and curing concrete, surfaces shall be protected by an impermeable membrane from direct exposure to carbon dioxide, combustion gases, or drying from heaters.
- .11 Honeycomb or embedded debris is not acceptable.
- .12 Completely remove and replace defective concrete.
- .13 Maintain accurate records of cast-in-place concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

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3.2 Cold Weather Concreting

- .1 When the mean daily temperature may fall below 5°C during placing or curing concrete, a complete housing of the Work, complete with heaters, fuel, maintenance, and attendants, shall be provided.
- .2 Supplementary equipment as required below shall be at the job Site if concrete is likely to be placed in cold weather.
- .3 Forms, reinforcing steel, and existing adjacent concrete shall be heated to at least 5°C before concrete is placed.
- .4 The temperature of the concrete shall be maintained at not less than 10°C for seven (7) days. Following that, the concrete shall be kept above freezing temperature for a period of at least seven (7) days. In no case, shall the heating be removed until the concrete has reached a minimum compressive strength which will be specified by the Contract Administrator as determined from compressive strength tests on specimens cured under the same conditions as the concrete Works in question.
- .5 Aggregates shall be heated to a temperature of not less than 20°C and not more than 65°C. Water shall be heated to a temperature between 55°C and 65°C. The temperature of the concrete at the time of placing shall be within the range specified in CAN/CSA A23.1-04 for the thickness of the section being placed.
- .6 Combustion-type heaters may be used if their exhaust gases are vented outside the enclosures and not allowed to come into contact with concrete surfaces. Fire extinguishers must be readily at hand wherever combustion-type heaters are used.
- .7 Before depositing any of the concrete, the Contractor shall show that enough heating equipment is available to keep the air temperature surrounding the forms within the specified range. This shall be accomplished by bringing the temperature inside of the housing to the specified 10°C at least twelve (12) hours prior to the start of the concrete placing.
- .8 When the ambient temperature is below -15°C, the housing shall be constructed so as to allow the concrete to be placed without the housing having to be opened. If the mixing is done outside of the housing, the concrete shall be placed by means of hoppers installed through the housing. The hoppers are to be plugged when not in use.
- .9 When the ambient temperature is equal to or above -15°C, the Contractor will be permitted to open small portions of the housing for a limited time to facilitate the placing of the concrete.
- .10 The Contractor shall supply all required heating apparatuses and the necessary fuel. When dry heat is used, a means of maintaining atmospheric moisture shall be provided.
- .11 Sufficient standby heating equipment must be available to allow for any sudden drop in outside temperatures and any breakdowns which may occur in the equipment.

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- .12 The Contractor shall keep a curing record of each concrete pour. The curing record shall include date and location of the pour, mean daily temperature, temperatures above and below the concrete within the enclosures, temperatures of the concrete surface at several points, and notes regarding the type of heating, enclosure, unusual weather conditions, etc. This record shall be available for review by the Contract Administrator at all times, and shall be turned over to the Contract Administrator at the end of the concreting operations.

3.3 Hot Weather Concreting

.1 General

- .1 The requirements of this section shall be applied during hot weather, i.e., air temperatures above 25°C during placing.
- .2 Concrete shall be placed at as low a temperature as possible, preferably below 15°C, but not above 27°C. Aggregate stockpiles may be cooled by water sprays and sun shades.
- .3 Ice may be substituted for a portion of the mixing water provided the ice has melted by the time mixing is completed.
- .4 Form and conveying equipment shall be kept as cool as possible before concreting by shading them from the sun, painting their surfaces white, and/or the use of water sprays.
- .5 Sun shades and wind breaks shall be used as required during placing and finishing.
- .6 Work shall be planned so that concrete can be placed continuously and completely within each filter cell.
- .7 The Contract Administrator's acceptance is necessary before the Contractor may use admixtures such as retardants to delay setting, or water-reducing agents to maintain workability and strength, and these are to be included in the mix designs submitted to the Contract Administrator.
- .8 Curing shall follow immediately after the finishing operation

.2 Hot-Weather Curing

- .1 When the air temperature is at or above 25°C, curing shall be accomplished by water or by using saturated absorptive fabric, in order to achieve cooling by evaporation.

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.3 Job Preparation

- .1 When the air temperature is at or above 25°C, or when there is the probability of its rising to 25°C during the placing period, facilities shall be provided for protection of the concrete in place from the effects of hot and/or drying weather conditions. Under severe drying conditions, as defined in Clause 3.3.5.2 of this Specification Section, the forms, reinforcement, and concreting equipment shall be protected from the direct rays of the sun or cooled by fogging and evaporation.

.4 Concrete Temperature

- .1 The temperature of the concrete as placed shall be as low as practicable and in no case greater than that shown below:

Temperatures (°C)	
Minimum	Maximum
10	27

.5 Protection from Drying

.1 Moderate Drying Conditions

- .1 When surface moisture evaporation exceeds 0.75 kg per square metre per hour, windbreaks shall be erected around the sides of the structural element.

.2 Severe Drying Conditions

- .1 When surface moisture evaporation exceeds 1.0 kg per square metre per hour, additional measure shall be taken to prevent rapid loss of moisture from the surface of the concrete. Such additional measures shall consist of the following:

- .1 Erecting sunshades over the concrete during finishing and placing operations.
- .2 Lowering the concrete temperature.
- .3 Increasing humidity by applying fog spray immediately after placement and before finishing.
- .4 Care shall be taken to prevent accumulation of water that may reduce the quality of the cement paste.
- .5 Beginning the concrete curing immediately after trowelling.

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.3 Surface Moisture Evaporation Rate

- .1 The chart, Figure D.1, Annex D of CAN/CSA A23.1-04 shall be used to estimate surface moisture evaporation rates.

3.4 Concrete Protection for Reinforcement

- .1 Ensure reinforcement is placed to provide concrete cover in accordance with the Supply Contractor's requirements.

3.5 Construction Tolerance

- .1 The Work shall be carefully and accurately set out; true to the positioning, levels and dimensions shown on the Supply Contractor's Drawings to tolerances shown below:
- .1 Thickness of Slabs: +6 mm, -0 mm.
 - .2 Cover of Concrete over Reinforcement: ± 3 mm.
 - .3 Embedded nozzle locations: ± 3 mm.
- .2 If these tolerances are exceeded the Contractor may, at the discretion of the Contract Administrator, be required to remove and replace the placed concrete before acceptance. The costs incurred by the Contract Administrator for such investigation, testing, or review of reconstruction and the cost of reconstruction shall be borne by the Contractor.

3.6 Finishing Slab Surfaces

- .1 Concrete flatwork finishing is to be done by skilled personnel having at least five (5) years of proven, satisfactory experience in this trade. Submit proof of qualifications in writing to the Contract Administrator.
- .2 Finish all slab surfaces conforming to CAN/CSA A23.1-04, Clause 7.5. Surface tolerances shall meet the requirements of Clause 7.5.1.2. Slab finish procedure shall be in accordance with Table 22, Class A modified as follows:
Straightedge value +0mm, -8mm.
- .3 Comply with the following requirements of the Supply Contractor: Scream, then single steel trowel finish the concrete to the top level of concrete inserts. The inserts are provided with factory installed red protection plugs.

3.7 Curing and Protection

- .1 Cure and protect freshly placed concrete in accordance with Clause 7.4 of CAN/CSA A23.1-04.

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- .2 All concrete shall receive moist curing for a period of at least seven (7) days. One (1) or more of the following methods shall be used as soon as the concrete has hardened sufficiently to prevent marring:
 - .1 Surface covered with canvas or other satisfactory material and kept thoroughly and continuously moist.
 - .2 A liquid membrane forming curing sealer, applied at the rate recommended by the Manufacturer.
 - .3 Supply Contractor's requirements.
- .3 No concreting will be allowed until all materials required for the curing phase are on Site and ready for use.
- .4 At the end of the curing and protection period, the temperature of the concrete shall be reduced gradually at a rate not exceeding 10°C per day until the outside air temperature has been reached.
- .5 Concrete that is allowed to freeze or attain insufficient curing conditions shall be subject to all necessary investigations and testing as deemed necessary by the Contract Administrator and all such concrete shall be removed and the portion reconstructed as directed by the Contract Administrator, at Contractor's cost.
- .6 The supply (both quantity and time of supply) of water for curing concrete shall be subject to control of the City and prior arrangements shall be made by the Contractor with the City for its supply. The Contractor shall be responsible for, at his own cost, to supply, install, maintain, and move extensions to water services as required for conveying water to the work Site. Water required for curing concrete will be supplied by the City, from the Deacon Booster Pumping Station (DBPS).

3.8 Defective Concrete

- .1 Concrete not meeting the requirements of the Specifications and Supply Contractor's Drawings will be considered defective concrete.
- .2 Concrete not conforming to the lines, details, and grades specified herein or as shown on the Supply Contractor's Drawings shall be replaced at the Contractor's expense and to the satisfaction of the Contract Administrator. Finished lines, dimensions, and surfaces shall be correct and true within tolerances specified herein.
- .3 Concrete not properly placed resulting in honeycombing and other defects shall be completely replaced.

3.9 Fabrication of Reinforcing Steel

- .1 Fabricate reinforcing steel in accordance with CAN/CSA A23.1-04 and Supply Contractor's Drawings.

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- .2 All bending shall be done cold with a suitable machine accurately producing all lengths, depths, and radii shown on the bending details.
- .3 After initial fabrication, reinforcing steel shall not be rebent or straightened.

3.10 Installation of Reinforcing Steel

- .1 Place reinforcing steel in accordance with the Supply Contractor's Drawings and CAN/CSA A23.1-04. Tie reinforcing steel at maximum spacing 600 mm.
- .2 Place reinforcing steel to provide concrete cover required by CAN/CSA A23.1-04, but not less than shown on the Supply Contractor's Drawings.
- .3 Do not disturb or damage inserts and forms while placing reinforcing steel.

3.11 Cleaning Reinforcing Steel

- .1 Ensure concrete reinforcing is clean and free from oil and deleterious matter.
- .2 Remove all loose scale, loose rust, concrete from prior pours, and other deleterious matter from surfaces of reinforcing.
- .3 Remove concrete splatter on bars before concrete is hardened.

3.12 Clean-up

- .1 As Work progresses and at the completion of Work, remove from Site all debris, excess materials, and equipment.

END OF SECTION