

PART 1 - GENERAL

1.1 Related Sections

- .1 Section 01 35 29 - Health and Safety Requirements.
- .2 Section 01 45 00 - Testing and Quality Control.
- .3 Section 01 74 21 - Construction/Demolition Management and Disposal.
- .4 Section 03 10 00 - Concrete Forming.
- .5 Section 03 20 00 - Concrete Reinforcing.
- .6 Section 03 35 00 - Concrete Finishing.
- .7 Section 31 23 10 - Excavating, Trenching and Backfilling.

1.2 References

- .1 Canadian Standards Association (CSA).
  - .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction.
  - .2 CAN/CSA-A5-03, Portland Cement, in accordance with CAN/CSA A3000-08, Cementitious Materials Compendium.
  - .3 CAN3-A266.1-M78, Air Entraining Admixtures for Concrete.
  - .4 CAN3-A266.2-M78, Chemical Admixtures for Concrete.
  - .5 CAN3-A266.4, Guideline for the Use of Admixtures in Concrete.
  - .6 CAN/CGSB-51.34-M86 Amend., Vapour Barrier, Polyethylene Sheet for use in Building Construction.
  - .7 CAN/CSA S6-06(R2011) - Canadian Highway Bridge Design Code.
- .2 ACI 117-10, Standard Tolerances for Concrete Construction and Materials.
- .3 ASTM C33/C33M-13, Standard Specification for Concrete Aggregates.

1.3 Certificates

- .1 Minimum 4 weeks prior to starting concrete work, submit to Departmental Representative manufacturer's test data and certification by qualified independent inspection and testing
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laboratory that the following materials will meet specified requirements:

- .1 Portland Cement.
- .2 Blended hydraulic cement.
- .3 Supplementary cementing materials.
- .4 Grout.
- .5 Admixtures.
- .6 Aggregates.
- .7 Water.
- .8 Joint filler.

.2 Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA-A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.

.3 Provide certification from a qualified independent inspection and testing company that plant, equipment, and materials to be used in concrete comply with requirements of CSA-A23.1/A23.2.

.4 Submit certification for the concrete supplier from the Atlantic Provinces Ready Mixed Concrete Association - APRMCA Concrete Production Facilities Certification Program.

1.4 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with the Section 01 74 21 - Waste Management and Disposal.

.2 Use trigger operated spray nozzles for water hoses.

.3 Designate a cleaning area for tools to limit water use and runoff.

.4 Carefully coordinate the specified concrete work with weather conditions.

.5 Ensure emptied containers are sealed and stored safely for disposal away from children.

.6 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate

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safety precautions collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal. Dispose of all waste in accordance with applicable local, provincial and national regulations.

- .7 Choose least harmful, appropriate cleaning method which will perform adequately.

#### 1.5 Design Requirements

- .1 Alternative 1 - performance; in accordance with CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.

#### 1.6 Submittals

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 At least 4 weeks prior to commencing work, inform Departmental Representative of proposed source of aggregates and provide access for sampling.
- .3 As a minimum, submit concrete mix information for each mix containing the following information:
  - .1 Cement type.
  - .2 Minimum compressive strength at 28 days.
  - .3 Exposure classification.
  - .4 Slump at time of discharge.
  - .5 Nominal size of coarse aggregate.
  - .6 Air content (%).
  - .7 Supplementary cementing materials type.
  - .8 Percentage of supplementary cementing materials by weight of total cementing materials.
  - .9 Cement content (kg/m<sup>3</sup>).
  - .10 Water-to-cement ratio.
  - .11 Proposed admixtures.

#### 1.7 Quality Assurance

- .1 Quality Assurance: in accordance with Section 01 45 00 - Testing and Quality Control.
  - .2 Submit to Departmental Representative, minimum four weeks prior to starting concrete work, 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
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that materials used in concrete mixture will meet specified requirements.

- .3 Minimum 4 weeks prior to starting concrete work, submit proposed quality assurance procedures for review by 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 At least fifteen (15) days prior to the start of the concrete construction schedule, a pre-concrete conference must be held. The mix designs shall be reviewed, and the required methods and procedures to achieve the required concrete shall be discussed. Send a pre-concrete conference agenda to all the attendees ten (10) days prior to the scheduled date of the conference.
  - .5 Arrange for representatives of all parties concerned with the concrete work to attend the conference, including but not limited to the following:
    - .1 The Contractor's superintendent.
    - .2 A representative from the laboratory responsible for the concrete mix design.
    - .3 A representative from the laboratory responsible for field quality control.
    - .4 The concrete subcontractor.
    - .5 The ready mix concrete producer.
    - .6 The admixture manufacturer supplier.
    - .7 The hardener supplier.
    - .8 The concrete pumping contractor.
    - .9 The Engineer.
    - .10 The Departmental Representative.
  - .6 Record minutes of meeting and distribute to all parties concerned within five (5) days of meeting. Submit minutes to Departmental Representative.
  - .7 Quality Control Plan: submit written report to Departmental Representative verifying compliance that concrete in place meets performance
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requirements of concrete as established in PART 2 - PRODUCTS.

- .8 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.8 Delivery, Storage and Handling

Concrete hauling time: maximum allowable time for concrete to be delivered to site of Work and discharged not to exceed 120 minutes after batching.

- .1 Modifications to maximum time limit must be agreed to Departmental Representative and concrete producer as described in CSA A23.1/A23.2.
- .2 Deviations to be submitted for review by Departmental Representative.
- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

PART 2 - PRODUCTS

2.1 Materials

- .1 Portland cement: Type as specified for specific mix in attached Table 2.2, and GU to CSA-A3001 and CAN/CSA-A5.
- .2 Supplementary cementing materials: replacement to CAN/CSA A3001. Minimum and maximum content as per Part 2.2, Mixes. Acceptable types:
  - .1 Fly Ash Type "F"
  - .2 Ground Granulated Blast Furnace Slag Type "S"
  - .3 Silica Fume Type "SF"
- .3 Water: to CSA-A23.1/A23.2.
- .4 Aggregates: to CSA-A23.1/A23.2. Coarse aggregates to be normal density.
  - .1 Coarse Aggregates to be normal density.
  - .2 Fineness modulus of fine aggregates shall be not less than 2.3, no more than 3.1 as per ASTM C33/C33M.
  - .3 Limit deleterious substances in coarse aggregates to ASTM C33/C33M for Class Designation S for Cold Climates.
- .5 Air entraining admixture: to ASTM C260, CSA-A23.1/A23.2 and CAN3-A266.1. Add air

entraining agent to mixes as indicated.

- .6 Chemical admixtures: to CSA-A23.1/A23.2, clause 6.3 and to CAN3 A266.4. Departmental Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
  - .7 Obtain authorization from Departmental Representative for use of super plasticizing admixture, water reducer and other admixtures. Add plasticizer, water reducer and/or other admixtures as approved by Departmental Representative to achieve desired concrete properties. Pay for all admixtures required.
  - .8 Concrete shall be normal and shall have a unit weight of 2350 kg/m<sup>3</sup>.
  - .9 Concrete retarder: to ASTM C494/C494M-10. Do not allow moisture of any kind to come in contact with retarder film.
  - .10 Joint Sealant: acceptable products include:
    - .1 For horizontal joints: two component polyurethane self-leveling elastomeric sealant.
    - .2 For vertical joints: polyurethane non-sag elastomeric sealant.
    - .3 Primer to be compatible with sealant.
  - .11 Concrete sealer: as per Section 03 35 00 - Concrete Finishing.
  - .12 Curing compound: to CSA-A23.1/A23.2.
  - .13 Isolation Joint fillers:
    - .1 Bituminous impregnated fiber board: to ASTM D1751.
  - .14 Dampproof membrane:
    - .1 Polyethylene membrane
      - .1 Polyethylene film, minimum 10 mil thickness.
      - .2 Puncture Resistance: 3000 grams ASTM D-1709.
      - .3 Water Vapor Permeance: less than .02 perms, ASTM F-1249/ASTM E-96
      - .4 Membrane tape as recommended by membrane manufacturer to
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seal all joints.

- .15 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland Cement, water-reducing and plasticizing agents to CAN/CSA A23.1/A23.2.
  - .1 Compressive strength: 50 MPa (7050psi) at 28 days.
  - .2 Net shrinkage at 28 days: maximum 2%.
  - .3 Fluid: to ASTM C827. Time of efflux through flow cone to ASTM C939: under 30 seconds.
  - .4 Flowable: to ASTM C827. Flow table, 5 drops in 3 seconds (ASTM C109/C109M) 125-145%.
  - .5 Plastic: to ASTM C827. Flow table, 5 drops in 3 seconds, (ASTM C109/C109M), 100% to 125%.
- .16 Non premixed dry pack grout: composite of non metallic aggregate Portland Cement with sufficient water for mixture to retain its shape when made into ball by hand and capable of developing compressive strength of 50 MPa (7250psi) at 28 days.
- .17 Ribbed waterstops: extruded PVC of sizes indicated, min 150 mm (6"):
  - .1 Tensile strength: to ASTM D412-06, Method A, Die "C", minimum 10 MPa (1450psi).
  - .2 Elongation: to ASTM D412-06, Method A, Die "C", minimum 275%.
  - .3 Tear resistance: to ASTM D624, Method A, Die "B", minimum 30 kN/m (2000 lb/ft).
  - .4 Corners and intersecting pieces shall be shop welded with legs not less than 500 mm (20") long.
- .18 Damp proofing: emulsified asphalt, mineral colloid type, unfilled: to CAN/CGSB-51.34.

## 2.2 Mixes

- .1 Proportion normal density concrete in accordance with. CSA-A23.1/A23.2, alternative 1 - performance.
  - .2 Use trigger operated spray nozzles for water hoses.
  - .3 Designate a cleaning area for tools to limit water use and runoff.
  - .4 Carefully coordinate the specified concrete work with weather conditions.
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- .5 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .6 Where admixtures are used, do not allow end-of-truck slump with admixtures to exceed 150mm.
- .7 In sufficient time before placement, submit all concrete mix designs to Departmental Representative for approval. No concrete shall be placed before mix designs are approved.
- .8 Obtain authorization from Departmental Representative for use of super plasticizing admixture, water reducer and all other admixtures. Add plasticizer, water reducer and/or other admixtures as approved by Departmental Representative to achieve desired concrete properties. Pay for all admixtures required.
- .9 Provide quality management plan to ensure verification of concrete quality to specified performance.
- .10 Use of Calcium Chloride not permitted.

### PART 3 - EXECUTION

#### 3.1 Preparation

- .1 Obtain Departmental Representative's approval before placing concrete. Provide 24 hours notice prior to placing of concrete.
  - .2 Place, consolidate, finish, cure and protect concrete to CAN/CSA-A23.1 except where specified otherwise.
  - .3 Pumping of concrete is permitted only after approval of equipment and mix.
  - .4 Secure in position reinforcing steel, embedded parts, anchor bolts and dowels etc. prior to placing concrete and ensure these are not disturbed during concrete placement in accordance with CAN/CSA A23.1.
  - .5 Prior to placing of concrete obtain Departmental Representative's approval of proposed method
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- for protection of concrete during placing and curing in adverse weather.
- .6 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
  - .7 Do not place load upon new concrete until authorized by Departmental Representative.
  - .8 During concreting operations:
    - .1 Development of cold joints not allowed.
    - .2 Ensure concrete delivery and handling facilities placing with minimum of rehandling, and without damage to existing structure or work.
  - .9 Ensure that reinforcement and formwork are thoroughly clean before placing.
  - .10 Place concrete in dry conditions.
  - .11 Place cast-in-place footings on soil or structural fill. Soils preparation beneath footings shall be in accordance with the Geotechnical Investigation Report. Geotechnical Engineer shall ensure compliance with the recommendations noted herein and in the geotechnical report.
  - .12 Ensure that foundation bearing materials are free from water and frost. Remove previously frozen bearing materials.
  - .13 Keep excavation dry while placing concrete.
  - .14 All dowels shall be placed before concrete footings are poured.
  - .15 Ensure reinforcement and inserts are not disturbed during concrete placement.
  - .16 All exterior footings shall be founded at least the depth of frost penetration below finished exterior grade. Isolated or unheated footings shall be founded at least the depth of frost penetration below finished exterior grade. Depths as shown on geotechnical report. Where depth on drawings is deeper, provide as per drawings.
  - .17 Maintain adequate frost protection to all soils under footings and slab on grade for entire duration of work.
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- .18 Protect previous work from staining.
- .19 Bond fresh concrete to hardened concrete to CAN/CSA A23.1.
- .20 Do not permit vertical free fall of concrete mix to exceed 1500 mm.
- .21 Concrete trucks or any other vehicles are not permitted to drive on dampproof membrane or reinforcing mats.

### 3.2 Construction

- .1 Do cast-in-place concrete work in accordance with. CSA-A23.1/A23.2.
  - .2 Construction Joints
    - .1 Construction joint locations shall be approved by Departmental Representative wherever they are not specifically designated on drawings.
    - .2 Surface of concrete construction joints shall be cleaned and laitance removed.
    - .4 Locate construction joints in wall and footings so as to least impair the strength of the structure and to Departmental Representative's approval. Construction joints shall be as detailed on design drawings.
    - .5 Immediately before concrete is placed, all construction joints shall be wetted and standing water removed.
    - .6 Prepare surface of initial slab pour prior to casting second pour. Remove laitance from full extent of first pour to receive new concrete. Roughen surfaces to an amplitude of 6mm. Lightly wet surface of parent concrete directly prior to pouring new concrete.
    - .7 Strength of initial slab pour shall exceed 30 MPa at time of casting second pour. Notwithstanding the above, the age of initial slab pour shall not exceed 140 hours.
  - .3 Joint fillers.
    - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Departmental Representative. When more than one piece is required for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
    - .2 Locate and form isolation, construction, expansion joints as indicated and as per CAN/CSA A23.1. Supply and install joint filler.
  - .4 Waterstops.
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.1 Provide waterstops to provide continuous water seal. Do not distort or pierce waterstop in such a way as to hamper performance. Do not displace reinforcement when installing waterstops. Use equipment to manufacturer's requirements to field splice waterstops. Tie waterstops rigidly in place.

.2 Use only straight heat sealed butt joints in field. Use factory welded corners and intersections unless otherwise approved by Departmental Representative.

.5 Concrete shall not be placed on or against any surface (including rebar) that is at a temperature below 5°C (40°F).

.6 Concrete at time of deposit shall be between 10°C (50°F) and 30°C (85°F).

.7 Pour concrete continuously between predetermined construction and control joints.

.8 Carry out winter concreting in strict accordance with CSA-A23.1/A23.2.

.9 Carry out hot weather concreting in accordance with CAN/CSA A23.1.

.10 Top surface of vertically formed lifts shall be generally level.

.11 Fill all construction joints in the completed concrete work minimum 28 days after casting employing an epoxy injection technique approved by Departmental Representative to completely seal cracks.

### 3.3 Field Quality Control

.1 Quality Control Inspection and testing of concrete and concrete materials will be carried out by an independent testing agency in accordance with CAN/CSA A23.1/A23.2.

.2 For compressive strength testing of concrete a minimum of 3 cylinders and 2 field cured cylinders are required for:

.1 Each day's pour.

.2 Each type of grade of concrete.

.3 Each change of supplier.

.4 Each 40 cubic meter or fraction thereof for footings and foundation walls.

.5 Test cylinders are required for testing at 7, 14 and 28 days as per requirements of CAN/CSA A23.1.

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.6 Test cylinders are required for testing at 56 days, in addition to requirements of CAN/CSA A23.1.

.7 Conduct at least one slump and one air entrainment test with each compressive strength test.

.8 Additional test specimen shall be taken whenever requested by Departmental Representative to verify concrete quality.

.9 Additional test specimen shall be taken during cold weather concreting.

- .3 Cure cylinders on job site under same conditions as concrete which they represent.
- .4 Non-destructive Methods for Testing Concrete shall be in accordance with CSA-A23.1/A23.2.
- .5 Inspection and testing by testing laboratory will not augment or replace contractor quality assurance nor relieve contractor of contractor responsibility.

### 3.4 Concrete Cover Over Reinforcement

- .1 Ensure reinforcing steel is placed to specified tolerances.
- .2 Concrete cover around reinforcing steel shall be as follows unless noted on drawings:
  - .1 Top surface of buried structure: 70mm
  - .2 Soffit of Slab: 60mm
  - .3 Vertical Surfaces of Walls: 70mm
  - .4 Top and Sides of Footings: 70mm
  - .5 Bottom of Footing: 100mm
- .3 The preceding clear covers to be maintained within tolerances as per CAN/CSA S6.
- .4 Provide continuous supervision during placement of concrete to ensure that reinforcing steel is maintained in its correct position.

### 3.5 Finishing

- .1 Finish concrete in accordance with Specification Section 03 35 05 - Concrete Finishing.

### 3.6 Curing

- .1 Cure concrete in accordance with CAN/CSA A23.1.
  - .2 Ensure that freshly placed concrete is
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protected from freezing, dehydration, mechanical shock and contact with injurious substances.

- .3 Use curing compounds compatible with applied finish on concrete. Do not use curing compounds that would have a detrimental effect on bonding, adhesion, curing, appearance, or similar qualities of materials applied to concrete surfaces. Use only moisture curing where finishes are incompatible with curing compound. Note - Slab concrete to be wet cured.
  - .4 Protect the concrete from premature drying and extremes of temperature.
  - .5 Cure, protect and finish concrete to CAN/CSA A23.1, CSA S269.1 and S269.3. Curing type in accordance with specified exposure classification unless more stringent requirements are noted otherwise. Special curing and finishing requirements are as follows:
    - .1 Rigid Portal Frame: curing "TYPE 2". Seven (7) days total at  $>10^{\circ}\text{C}$  and  $<21^{\circ}\text{C}$  and for the time necessary to attain 70% of the specified concrete strength.
    - .2 Footings: curing "TYPE 2". Seven (7) days total at  $>10^{\circ}\text{C}$  and  $<21^{\circ}\text{C}$  and for the time necessary to attain 70% of the specified concrete strength.
  - .6 Do not remove forms or shoring during curing period.
  - .7 Wet cure shall be done in accordance with CSA-A23.1/A23.2 and shall be done by:
    - .1 Non-staining absorptive mat fabric kept continuously wet.
    - .2 Additionally, curing mats shall be thoroughly wet when applied and kept continuously wet in intimate contact with the concrete surface for the duration of the moist curing period. Mats shall be long enough to cover the entire width and edges of the concrete and lapped at joint to prevent drying between adjacent sheets. Mats shall be applied to concrete immediately after disappearance of surface water sheen after the final
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finishing pass.

.3 End laps shall be at least 75 mm and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during period using cover material and waterproof tape.

.4 Remove curing cover and allow concrete to air dry for at least twelve (12) hours prior to applying liquid densifier/sealer.

.8 Foot traffic shall be kept off curing concrete for 1 day.

.10 Vehicles shall be kept off concrete for 7 days.

### 3.7 Defective Work

.1 Repairs and classification of unacceptable concrete to be in accordance with CSA-A23.1/A23.2.

.2 Remove defective concrete and embedded debris and repair as directed by Departmental Representative.

.3 A cold joint, honeycombing or embedded debris in any concrete shall deem it defective. Remove and replace defective concrete as directed by Departmental Representative.

.4 Remove to bare concrete curing compounds detrimental to application of specified finishes.

.5 Concrete to be supplied at the minimum strength requirement at 28 days. Tests indicating strengths lower than specified will necessitate further testing as required by Departmental Representative. Cost for such testing to be at the Contractor's expense. Should further tests confirm low values, Departmental Representative has the right to require strengthening of the affected area or removal and replacement of weak concrete all to the Contractor's expense.

.6 Repair all shrinkage cracks in the completed concrete work minimum 28 days after casting employing an epoxy injection technique acceptable to Departmental Representative to completely seal all such cracks.

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3.8 Tolerances

.1 Concrete tolerance in accordance with  
 CSA-A23.1/A23.2.

Table 2.2

Mix	i	ii
	Mud slabs and fill under foundations	Portal Frame and Foundations
Exposure Classification:	N	C1
Min. compressive strength at 28 days	20 MPa	35 MPa
Portland Cement Type:	GU	GU
Maximum w/cm ratio:	0.65	0.40
Max slump at time of discharge:	**	80 mm **
Nominal size of coarse aggregate	10 mm	20 mm
Air content	Not Req'd	5-8%
Min. SCM*:	15%	10%
Max. Silica Fume Content:	3%	5%
Max. Total SCM*:	25%	20%
Min. Cement Content (incl. SCM*)	-	335 kg/m <sup>3</sup>

\* SCM = Supplementary Cementing Materials (Fly-Ash, Silica Fume, and/or Slag as specified)

\*\* In accordance with CAN/CSA A23.1.

When value is given, it is prior to addition of plasticizers.

+/- tolerance as per CAN/CSA A23.1.

Read in conjunction with Part 2.2 - Mixes regarding slump and admixtures.

END