

SECTION 11 – CAST IN PLACE CONCRETE WORKS

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SECTION 11 – REINFORCED AND PLAIN CONCRETE WORKS

SPECIFICATIONS AND INSTALLATION (REVISED MAY 2020)

11.20 SCOPE

- .1 This specification refers to reinforced and plain cast in place concrete works for the construction of pavements, sidewalks, curbs and gutters, manholes, catch basins, concrete works associated with the installation of watermains and sewers and other works incidental to municipal services construction.
- .2 This specification shall not be used for structural facilities such as buildings, bridges or other structure requiring site specific structural design.

11.21 RELATED SECTIONS

- .1 Section 4.0 – Excavation, Trenching and Backfill.
- .2 Section 8.0 – Transportation, and Section 9.0 Aggregates and Granular Material.

11.22 REFERENCES, CODES AND STANDARDS

- .1 All references to this Specifications, Standards and Codes shall refer to the latest adopted version, including all amendments.
- .2 American Concrete Institute (ACI):
 - (a) ACI 306 R – Cold Weather Concreting.
 - (b) ACI 305 R – Hot Weather Concreting.
- .3 American Society for Testing and Materials (ASTM):
 - (a) ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
 - (b) ASTM C309 – Standard Specification for Liquid Membrane – Forming Compounds for Curing Concrete.
- .4 Canadian Standards Association (CSA):
 - (a) CSA A23.1/A23.2:19 – Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.
 - (b) CSA A283:19 – Qualification code for concrete testing laboratories.
 - (c) CSA A3000-18 – Cementitious Materials Compendium.

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- .5 Codes and Bylaws:
- (a) Local codes and bylaws
 - (b) WorkSafeBC Regulations
 - (c) National Building Code (NBC)
 - (d) British Columbia Building Code (BCBC)

11.23 SUBMITTALS

- .1 Mix Design:
- (a) Provide certification by the Engineer that the mix proportions will produce concrete of specified quality and yield and that strength will comply with this specification and CSA A23.1:19.
- .2 Plant and Material Certification:
- (a) Concrete suppliers shall submit certification of concrete production facilities in accordance with the British Columbia Ready Mixed Concrete Association (BCRMCA) audit check list.

11.24 MATERIALS

- .1 Hydraulic cement: Type GU (general use) to CSA A3000-18:
- (a) Other types of cement shall only be permitted with the Engineer's approval.
- .2 Fly Ash: Type F to CSA A3000-18.
- .3 Water: to CSA A23.1:19.
- .4 Aggregates: to CSA A23.1:19, Table 12:
- (a) Coarse aggregate – combined grading of blended coarse aggregate to be within limits of Table 11 (Group 1).
 - (b) Nominal size of aggregate shall be 20 mm for concrete works and 14 mm for concrete patching.
 - (c) Fine aggregate – gradation to CSA A23.1:19, Table 10 and be within limits of FA1.
- .5 Admixtures:
- (a) Air entraining admixture: to ASTM C260.
 - (b) Chemical admixtures: to ASTM C494. Set retarding and accelerating admixtures shall not be used unless approved by the Engineer.
- .6 Reinforcement:
- (a) Reinforcement for concrete and methods of testing reinforcement shall conform to the requirements of CSA A23.1 Section 6.1 and CSA G30.18.

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.7 Forms:

- (a) All forms shall conform to CSA A23.1:19, Section 6.5.
- (b) Form ties shall be metal and of the type such that no metal is left within 25 mm from the concrete surface when the forms are removed.
- (c) Form release agent shall be approved by the Engineer prior to use and shall be a non-staining, mineral type, with chemically active release agents containing compounds that react with free time to produce water soluble soap.

.8 Support, Chairs and Spacers:

- (a) Reinforcement shall be accurately positioned, secured and supported using bar supports, side form spacers and internal spacers to ensure proper concrete cover and spacing within allowable tolerances before and during placing of concrete.
- (b) All support of reinforcement shall conform to CSA A23.2:19, Section 6.6.7.

.9 Premoulded Joint Filler:

- (a) Premoulded joint fillers shall be bituminous impregnated fiber board in accordance with ASTM D1751.

11.25 CONCRETE MIXES

.1 Mix design for exterior walls and columns shall conform to the requirements of CSA A23.1, Table 1 and Table 2 or Class F-2.

- (a) Minimum compressive strength at 28 days: 25 MPa.
- (b) Maximum water to cementing materials ratio (w/cm): 0.55.
- (c) Air entrainment: 5% - 8%.
- (d) Slump shall be consistent with the placement and consolidation methods, equipment, and site conditions.

.2 Mix design for concrete curbs and sidewalks shall conform to requirements of CSA A23.1, Table 1 and Table 2 for Class C-2.

- (a) Minimum compressive strength at 28 days: 32 MPa.
- (b) Air entrainment: 5% - 8%.
- (c) Slump shall be consistent with the placement and consolidation methods, equipment, and site conditions.

.3 Control density fill should comply with CSA A23.1:19.

- (a) Minimum compressive strength at 28 days: 0.5 MPa.
- (b) Air entrainment: 4% - 7%.
- (c) Slump shall be consistent with the placement and consolidation methods, equipment and site conditions.

.4 Mix design for grout shall be approved by the Engineer. Proprietary grout mixtures shall be used in accordance with the manufacturer's recommendations.

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11.26 CONSTRUCTION

- .1 Install reinforced and plain concrete works, including surface tolerances, finishing and field quality control in accordance with CAN/CSA A23.1:19 except where specifically stated otherwise.
- .2 All concrete accessories shall be as indicated on the drawings or as approved in writing by the Engineer.
- .3 The Engineer shall be given 24 hours' notice in advance of placing concrete by the Contractor.
- .4 Concrete production and delivery shall be in accordance with CSA A23.1:19, Section 5.0.
- .5 Hot and cold weather concreting.
 - (a) When the ambient temperature is forecasted to be 27°C and raising, the requirements of VSA A23.3:19, Clause 7.8.3.3.1 shall be followed.
 - (b) During freezing weather, the requirements of VSA A23.3:19, Clause 7.8.3.3.2 shall be followed.
- .6 Concrete Testing:
 - (a) The Engineer will arrange for a CCIL certified testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates non-compliance with the specifications additional testing shall be required at the contractor's expense.
 - (b) Concrete sampling, curing and testing shall comply with CSA A23.2.
 - (c) Compressive Strength Test:
 - (i) Compressive strength shall be performed in conformance with CSA A23.2.
 - (ii) One strength test shall consist of 3 – 100 mm x 200 mm cylinders; one tested at 7 days, 2 tested at 28 days.
 - (iii) At least one strength test shall be made from each 50 cubic metres of concrete placed, or 150 m of curb and/or sidewalk placed, with a minimum of one test for each pour of a specified concrete strength placed each day.
 - (iv) The average of all 28 day strength tests shall exceed the specified strength. When 3 or more tests of the same class of concrete are available, the average of any 3 consecutive tests shall be equal to or greater than the specified strength. No strength tests shall fall below 85% of the specified strength.
 - (v) Reporting shall follow the requirements of CSA A23.2 – 9C, clause 9 Reporting.

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- (d) All concrete trucks shall supply a copy of the delivery slip to the Engineer containing the following information:
 - (i) Minimum Compressive Strength
 - (ii) Maximum Slump
 - (iii) Air Content by Percent of Volume
 - (iv) Batch Time
 - (v) Maximum Size of Aggregate
 - (vi) List of Admixtures
 - (vii) Date
 - (viii) Name of Supplier
 - (e) Air content testing of plastic concrete shall be conducted in accordance with CSA A23.2-4C. At least one air content test shall be made for each strength test.
 - (f) Slump of concrete shall be determined in accordance with SA A23.2-5C. At least one slump test shall be made for each strength test. The slump test is not required for machine extruded concrete using a no-slump mix design.
- .7 Inspection and testing by the Engineer shall not relieve the contractor of his responsibility for quality control.
- .8 Concrete found to be in non-compliance with these specifications, shall be repaired or replaced by the Contractor at no additional cost to the Owner. The Contractor shall submit to the Engineer for approval, his proposed method to correct the noted deficiencies, prior to commencing the work.

11.27 FORMWORK

- .1 Forms shall be so constructed that the finished concrete will conform to the shape, dimensions and finish specified.
- .2 Forms shall be constructed in conformance with WorkSafeBC regulations.
- .3 Forms and falsework shall be built sufficiently strong and rigid to maintain correct alignment and elevation and retain concrete pressures without deflection. Forms shall be sufficiently tight to prevent leakage of concrete.
- .4 Forms shall be treated with form release agent prior to placing of reinforcement.
- .5 Forms for surfaces which are to receive a plaster finish shall not be treated with form release agent.
- .6 Forms shall not be stripped until concrete has attained sufficient strength to support safely its own weight and all loads to which it may be subjected.
- .7 Forms shall be removed without damaging the concrete.

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11.28 HOOKS AND BENDS IN REINFORCEMENT

- .1 Fabrication of hooks and bends in reinforcing steel shall be in accordance with CAN/CSA A23.1.
- .2 Bars shall be cold bent, unless otherwise authorized by the Engineer. Bars that are partially embedded in concrete shall not be field bent unless shown on the drawings or authorized by the Engineer.
- .3 Replace bars which develop cracks or splits.

11.29 CLEANING REINFORCEMENT

- .1 Bars shall be free from loose rust, mud, oil or other bond-reducing coating.
- .2 Bars shall, if necessary, be recleaned prior to resumption of pouring if concrete placing is delayed during the course of a pour.
- .3 Touch up damaged parts and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.

11.30 PLACING REINFORCEMENT

- .1 Fabricate reinforcing steel in accordance with CAN/CSA A23.1, ANSA/ACI 315 and 315R. Upon approval by the Engineer weld reinforcement in accordance with CSA W186.
- .2 Reinforcement shall be placed accurately and securely supported by chairs, spacers and ties in accordance with the construction drawings.

11.31 SPLICES

- .1 Bars shall be spliced only where shown on the construction drawings or as authorized by the Engineer. Splicing shall be carried out in conformance with CAN/CSA A23.1.
- .2 Welding of reinforcement, where authorized by the Engineer, shall conform to CSA W186.

11.32 COVER FOR REINFORCEMENT

- .1 Supports, chairs and spacers shall be provided to ensure the specified cover.
- .2 A minimum of 75mm of cover for reinforcement shall be provided for concrete placed against the ground.
- .3 For surfaces to be exposed to the weather or in contact with the ground after removal of forms, the concrete cover shall be at least 50mm.
- .4 A minimum of 20mm concrete cover shall be provided for surfaces not exposed to earth or weather:

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11.33 CONCRETE JOINTS

.1 Construction Joints:

- (a) Construction joints shall comply with the requirement of CSA A23.1:19, Clause 7.3.1.
- (b) Construction joints not shown on the drawings shall be approved by the Engineer prior to construction of formwork and placement of reinforcement. The interface between concrete pours is classified as construction joint if fresh concrete cannot be incorporated integrally by vibration with that previously placed.
- (c) Joints shall be perpendicular to main steel.
- (d) Reinforcing steel and/or welded wire fabric shall be continuous across joints.
- (e) Before placing new concrete on hardened concrete, forms shall be re-tightened, the surface of concrete adequately roughened, laitance removed and the surface saturated with water in advance of concreting.
- (f) Joint preparation and installation of jointing materials shall be in accordance with the manufacturer's instructions.
- (g) Furnish filler for each joint in a single piece for the depth and width required for the joint, unless authorized by the Engineer. When more than one piece is authorized for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening methods.

.2 Curb and Sidewalk Expansion Joints:

- (a) Transverse expansion joints for curb and gutter shall be formed at both sides of lanes and driveway crossings, at both ends of all curb returns, and both sides of catch basins 1.0 m from the centerline of the catch basin and at all other locations designated by the Engineer.
- (b) Transverse expansion joints for sidewalks shall be formed at both sides of lanes and driveway crossings, at both ends of curb returns, at both sides of manholes, 0.75 m from the centerline of the manhole and at all other locations designated by the Engineer.
- (c) Extend joint through full depth of concrete. Fill joint with expansion joint material.

.3 Curb and Sidewalk Contraction Joints:

- (a) Contraction joints shall be constructed by cutting a groove through the surface of the concrete to a minimum of ½ of the depth of the concrete section at the point of cut.
- (b) Contraction Joints shall be Constructed:
 - (i) For sidewalks up to 3.0 m wide, lateral control joints shall be spaced at intervals equal to the width of the sidewalk.
 - (ii) For sidewalks wider than 3.0 m, lateral control joints shall be spaced at 3.0 m intervals, as well as longitudinal control joints, located such that a 2.0 m corridor is maintained.

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(c) Contraction Joints for Curbs shall be Constructed:

- (i) For curbs separated from sidewalk, control joints shall be spaced at 3.0 m intervals.
- (ii) For curbs abutting sidewalk, control joints shall be spaced to match the contraction joints in the adjacent sidewalk or multi-use pathway, with a minimum spacing of 2.0 m and maximum spacing of 4.0 m.

(d) Sidewalk slabs shall be uniform in size and cut square where possible.

.4 Curb and Sidewalk Isolation Joints:

- (a) Isolation joints shall be fabricated around telephone poles, light poles, hydrants, manholes, and all other structures located in the concrete section by wrapping 6 mm thick preformed bituminous impregnated fiber board material around the structure.
- (b) Longitudinal isolation joints shall be formed between sidewalk and existing curbing and where sidewalk is installed directly against a wall or other structure.
- (c) Bond break compound may be used in lieu of the isolation joint between sidewalk and abutting curb where approved by the Engineer.

11.34 SLEEVES AND OPENINGS

- .1 Pipes, castings or conduits passing through walls or floors shall, wherever possible, be place in forms before pouring concrete. Boxes may be built into forms to make form openings for subsequent insertion of such items only with the Engineer's approval.
- .2 Continuous keyways shall be provided throughout the perimeter of the opening and shall be flared slightly to facilitate the escape of entrapped air during grouting.

11.35 EMBEDDED ITEMS

- .1 Items that are to be embedded in concrete shall be properly set, held, leveled and aligned in forms.
- .2 Anchor bolts or other inserts shall be accurately set, held, leveled and aligned using templates.
- .3 Suitable nailing blocks, plugs, strips and other items required for attachment of architectural trim and finish shall be placed such that there is no visible distortion or defacement of the completed installation.

11.36 MIXING, PLACING AND CONSOLIDATING

- .1 Prior to placing concrete, obtain Engineer's approval of reinforcing material and placement.
- .2 Mixing, placing and compacting of concrete shall conform to CAN/CSA A23.1 and to the approval of the Engineer.

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- .3 Pumping of concrete shall require approval by the Engineer.
- .4 Placement and compacting of concrete shall not disturb reinforcement and inserts.
- .5 Extruded concrete shall be free from waves or irregularities in line or grade and be sufficiently supported to ensure no deflection occurs.
- .6 The Engineer, shall maintain accurate records of poured concrete to indicate date, location of pour, quality, air temperature and test samples taken.

11.37 SURFACE FINISHING

- .1 Finishing of concrete shall follow the requirements of CSA A23.1:19, Clause 7.7.

11.38 TYPES OF FINISHES AND TOLERANCES

.1 Float Finish:

Surfaces received a wood float finish shall be screeded in conformance with CAN/CSA A23.1 and then the concrete surface shall be worked with a long-handled darby or float to remove high spots and ridges and to fill voids and hollows left in the concrete surface by screeding.

.2 Broom Finish:

After float finishing, surfaces to be broom-finished shall be slightly roughed by light brooming with a stiff brush or broom to a uniform non-skid surface to the satisfaction of the Engineer. Finished surfaces shall be true in all planes within 8mm in 3.0m as determined by a 3.0m straightedge placed anywhere on the concrete.

.3 Trowel Finish:

After float finishing, surfaces to be trowel-finished shall be power-trowelled and finally hand-trowelled once the surface has hardened sufficiently. Finished surfaces shall be true in all planes within 5mm in 3.0m as determined by a 3.0m straightedge placed anywhere on the slab. The surface shall have a smooth, even, dense texture free from blemishes.

.4 Common Finish:

For a common finish formed surfaces shall have fins and protrusions exceeding 5mm ground off. Honeycombed or defective concrete shall be removed to sound concrete, an approved bonding agent applied and patched with mortar of cement and sand mixed in the same proportions as the concrete patches. Damp burlap curing shall be applied. Tieholes shall be cut back 25mm from the face and filled.

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.5 Rubbed Finish:

- (a) Forms shall be removed and any necessary patching completed as soon as possible after placement of the concrete without damage to the structure. The rubbed finish shall be undertaken when the surfaces are completed and accessible.
- (b) The concrete surfaces shall be thoroughly saturated with water and maintained wet for at least one hour before finishing operations are begun. All free water on the surface shall be removed prior to the application of the finishing mortar.
- (c) The mortar shall consist of one part cement and two parts sand (passing a 1.18mm sieve) by volume. The mortar shall be preshrunk by mixing at least one hour before it is used and then remixed without the addition of water prior to its use.
- (d) The sand and cement shall be the same materials as those used in the concrete.
- (e) The mortar shall be rubbed thoroughly over sections of the prepared concrete surfaces with clean burlap pads or other suitable materials so that all surface voids are filled. While the application mortar is still plastic, the surfaces shall be rubbed with the sack pads using a mixture of mortar of the same proportions as previously specified, except that no mixing water shall be used. The final rubbing shall be performed in such a manner that the filled voids are left flush with the surface of the surrounding concrete.
- (f) On exposed form surfaces, it may be necessary to blend white cement with the job cement in order to obtain a finish colour that will match the surrounding concrete surfaces. Trial batches of mortar should be made prior to application on the job surface to determine the correct mix proportions to be used.

11.39 SURFACE FINISHING

- .1 Unformed surfaces not exposed to view shall receive a float finish.
- .2 Unformed surfaces exposed to view, or receiving a floor covering, shall receive a trowel finish.
- .3 Concrete curb and gutter shall have a steel trowel finish.
- .4 Sidewalks shall receive a uniform broom finish.
- .5 Formed surfaces not exposed to view shall receive a common finish.
- .6 Formed surfaces exposed to view shall receive a rubbed finish.
- .7 Surface finishing may be noted on the drawings or, if not clear, shall be as directed by the Engineer.

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11.40 PROTECTION AND CURING

- .1 Freshly placed concrete shall be protected from damage caused by weather, construction operations and vandalism. Where concrete shows evidence of damage or freezing, as determined by the Engineer, the entire section shall be removed and replaced at the Contractor's expense.
- .2 Concrete curing shall comply with the requirements of CSA A23.1:19, Section 7.8. Curing requirements for the classes of exposure are given in Tables 2 and 19.
- .3 Curing methods shall comply with CSA Awe.1:19, Clause 7.8.2.1.
- .4 Moist curing shall commence immediately following the final set and shall continue uninterrupted for at least 7 days.
- .5 Curing compounds shall not be used unless expressly authorized by the Engineer. If approved, curing compound shall be spray applied, liquid type conforming to ASTM C309 containing a fugitive dye or pigmented.
- .6 Do not place load on the new concrete until authorized by the Engineer.