

**TABLE OF CONTENTS**

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**DIVISION 3**

<b>Section</b>	<b>Title</b>
03100	Concrete Formwork
03200	Concrete Reinforcement
03250	Concrete Accessories
03300	Cast-in-Place Concrete
03412	Precast Concrete Deck
03481	Precast Parking Curbs

## CONCRETE FORMWORK

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### 1. GENERAL

#### 1.1 Work Included

- .1 Forms for all concrete and supporting falsework including design
- .2 Formliner for interior wall surfaces of liquid retaining structures and containment
- .3 Wood and steel forms for all cast-in-place concrete
- .4 Void forms between structural elements and soil below where indicated
- .5 Shoring, bracing, and anchorage
- .6 Form openings for other trades
- .7 Coordinate installation of concrete accessories
- .8 Set anchor bolts, anchors, sleeves, frames, and other items supplied by other trades
- .9 Clean erected formwork prior to concrete placement
- .10 Remove forms and supporting falsework

#### 1.2 Design Standards

- .1 Design and detail forms and supporting falsework in accordance with the National Building Code of Canada, CAN/CSA-A23.1-00, CSA S269.1, CAN/CSA S269-3, ACI 347R, and applicable construction safety regulations.
- .2 Design to be sealed and signed by a Professional Engineer registered in the Province of Manitoba.

#### 1.3 Quality Assurance

- .1 Construct and erect concrete formwork in accordance with CAN/CSA-A23.1-00, CAN/CSA S269.3, ACI 347R, and all applicable construction safety regulations for the place of Work.

#### 1.4 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 01300 - Submittals.
- .2 Clearly indicate sizes, methods of construction, materials, arrangement of joints, ties and shores, location and size of falsework, schedule of erection and stripping, restoring, etc.
- .3 Shop Drawings and design briefs are to bear the seal of a Professional Engineer, registered in the Province of Manitoba.

## **CONCRETE FORMWORK**

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- .4 Formwork, falsework and reshoring are to be reviewed by the same Professional Engineer prior to each concrete pour.
- .5 Professional Engineer to report, in writing, that reviewed formwork, falsework and reshoring are in accordance with the design, prior to each concrete pour.

### **2. PRODUCTS**

#### **2.1 Exposed Surfaces**

- .1 Square-edged, smooth surfaced panels true in plane, free of holes, surface markings, or defects.

#### **2.2 Unexposed Surfaces**

- .1 Square-edged tongue and groove lumber, plywood or other material, suitable to retain concrete without leakage or distortion.

#### **2.3 Wood Materials**

- .1 Plywood: Douglas Fir, conforming to CSA O121-M solid one-side, sheathing grade. Sound undamaged sheets with clean true edges.
- .2 Lumber: conforming to CSA O141-M
- .3 Nails, spikes, and staples: galvanized; conforming to CSA B111

#### **2.4 Prefabricated Forms**

- .1 Steel type: minimum 1.6 mm steel thickness; well matched, tight fitting, and adequately stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface.
- .2 Tubular column type: round, spirally wound laminated fiber material, internally treated with release agent; sizes indicated on Drawings.
- .3 Void forms:
  - .1 Moisture-resistant treated paper faces; bio-degradable, structurally sufficient to support weight of wet concrete mix and construction loads until initial set under slabs, walls and beams unless noted.
  - .2 Below structural slabs of the Equalization tank, SBR 1 and SBR 2 tanks; Geo Void expanded polystyrene as manufactured by Plasti-Fab.

#### **2.5 Accessories**

- .1 Plain formliner: Zemdrain MD Type III by Dupont or accepted alternate.

## CONCRETE FORMWORK

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- .2 Form ties for water retaining structures: shall be cone-fast coil tie type or she bolt type as manufactured by Dywidag, to provide a 50 mm deep cone pocket for grouting after use. The portion of the form tie that remains in the concrete wall shall be plated and shall utilize a hydrophylic O ring waterstop at midspan. As an alternate to these ties, a tapered removable form tie may be employed. The hole to be grouted after removal must be mechanically cleaned to remove all remnants of release or debonding agents.
- .3 Form ties for non-water retaining elements: removable snap-off metal type, fixed length, minimum working strength of 13 kN when assembled and that leave a minimum cutback of 25 mm. Use plastic cone snap type or screw type on exposed surfaces. Wire ties are not permitted.
- .4 Form release agent: colourless mineral oil which will not stain concrete or impair natural bonding or colour characteristics of coating intended for use on concrete.
- .5 Corner fillets or chamfers: mill finished pine, 20 mm by 20 mm, maximum possible lengths, mitre ends.
- .6 Reglets: mill finished pine, shaped to required cross-section, maximum possible lengths, mitre ends.
- .7 Sealing tape: reinforced, self-adhesive, waterproof kraft.

### 3. EXECUTION

#### 3.1 Examination

- .1 Before starting this Work, examine Work done by others which affects this Work.
- .2 Notify the Contract Administrator of any conditions which would prejudice proper completion of this Work.
- .3 Commencement of Work implies acceptance of existing conditions.

#### 3.2 Erection

- .1 Verify lines, levels, and centres before proceeding with formwork. Ensure dimensions agree with Drawings.
- .2 Construct formwork and falsework to meet design and regulatory requirements, and to produce finished concrete conforming to surfaces, shapes, lines, and dimensions indicated on Drawings.
- .3 Arrange and assemble formwork to permit removal without damage to concrete.
- .4 Align joints and make watertight to prevent leakage of cement paste and disfiguration of concrete. Keep form joints to a minimum. Tape joints as necessary.

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### CONCRETE FORMWORK

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- .5 Arrange forms to allow removal without removal of principal shores, where these are required to remain in place.
- .6 Obtain the Contract Administrator's acceptance before framing openings in concrete slabs, walls, beams, and columns not indicated on Drawings.
- .7 Provide falsework to ensure stability of formwork. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.
- .8 Position form joints to suit any expressed lines required in exposed concrete.
- .9 Provide chamfer on all external corners and fillets on all internal corners and edges of exposed concrete unless shown otherwise.
- .10 Form chases, slots, openings, drips, and recesses as detailed on the Drawings.
- .11 Set screeds with top edge level to required elevations.
- .12 Check and readjust formwork to required lines and levels during placing of concrete.
- .13 Where construction joints are required in beams and suspended slabs, form joints at the third points in the span unless shown or noted otherwise on Drawings.
- .14 Provide reveals or reglets on construction joints as shown on the Drawings.

#### 3.3 Tolerance

- .1 Construct formwork to produce concrete with dimensions, lines, and levels within tolerances specified in ACI 347R, Guide to Formwork for Concrete.
- .2 Camber slabs and beams 6 mm per 3 m of span unless otherwise indicated on the Drawings. Review method of providing camber with Contract Administrator prior to proceeding. Maintain beam depth and slab thickness from cambered surface.

#### 3.4 Inserts, Embedded Items, and Openings

- .1 Provide formed openings where required for pipes, conduits, sleeves, and other Work to be embedded in and passing through concrete members.
- .2 Accurately locate and set in place items which are to be cast directly into concrete.
- .3 Coordinate Work of other Sections and Divisions and cooperate with trades involved in forming openings, slots, recesses, chases, and setting sleeves, bolts, anchors, and other inserts.
- .4 Coordinate installation of concrete accessories specified in Section 03250.
- .5 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

## CONCRETE FORMWORK

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- .6 Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so no leakage occurs, and to provide uniform surface on exposed concrete.

### 3.5 Field Quality Control

- .1 Inspect and check complete formwork, falsework, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and parts are secure.
- .2 Inform Contract Administrator when formwork is complete and has been cleaned, to allow for review. Contract Administrator's review will be for verification that earth bottoms are clean and that forms are clean and free from debris.
- .3 Re-use of forms shall be subject to the requirements of CAN/CSA-A23.1-00.

### 3.6 Cleaning

- .1 Clean formwork in accordance with CAN/CSA-A23.1-00.
- .2 During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out completed forms, unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.

### 3.7 Formwork Preparation

- .1 Apply form release agent in accordance with manufacturer's recommendations, prior to placing reinforcing steel, anchoring devices, and embedded parts.
- .2 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces moist prior to placing concrete.
- .3 Formliner shall be used on all interior and exterior surfaces of concrete surfaces of liquid containing structures and containments areas. It shall be installed in strict accordance with the manufacturer's instructions. The manufacturer's representative shall be on-site at the beginning of the formliner installation and as required to ensure recommended procedures are followed; a written report shall be submitted for each Site visit. Wrinkles or folding of the formliner during concrete placement will not be accepted.

### 3.8 Form Removal

- .1 Notify Contract Administrator prior to removing formwork.
- .2 Do not remove forms and falsework until concrete has gained either sufficient strength to carry its own weight plus construction loads and design loads that are liable to be imposed or 75 percent of design compressive strength, whichever is greater. Verify strength of concrete by compression tests.

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**CONCRETE FORMWORK**

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- .3 Remove falsework progressively, in accordance with regulatory requirements and ensure that no shock loads or imbalanced loads are imposed on structure.
- .4 Loosen forms carefully without damaging concrete surfaces. Do not apply tools to exposed concrete surfaces.
- .5 Leave forms loosely in place for protection until curing requirements are complete.

**END OF SECTION**

## CONCRETE REINFORCEMENT

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### 1. GENERAL

#### 1.1 Work Included

- .1 Reinforcing steel bars for cast-in-place concrete, complete with tie wire.
- .2 Support chairs, bolsters, bar supports, spacers and tie wire for reinforcing.

#### 1.2 Quality Assurance

- .1 Perform concrete reinforcing Work in accordance with CAN/CSA-A23.1-00.

#### 1.3 Inspection and Testing

- .1 If requested by Contract Administrator, submit three (3) certified copies of mill test report of reinforcement supplied, indicating physical and chemical analysis.

#### 1.4 Shop Drawings

- .1 Submit bar lists and placing Drawings in accordance with Section 01300.
- .2 Clearly indicate bar sizes, spacings, locations, and quantities of reinforcing steel, bending and cutting schedules, and supporting and spacing devices.
- .3 Drawings and details shall conform to CAN/CSA-A23.1-00, CAN/CSA-A23.3, and RSIC Reinforcing Steel Manual of Standard Practice.
- .4 Detail placement of reinforcing where special conditions occur.
- .5 Detail lap lengths and bar development lengths to CAN/CSA-A23.1-00, unless otherwise shown on the Drawings.

#### 1.5 Delivery and Storage

- .1 Deliver, handle, and store reinforcement in a manner to prevent damage and contamination.
- .2 Deliver bars in bundles, clearly identified in relation to bar lists.

### 2. PRODUCTS

#### 2.1 Reinforcing Materials

- .1 Reinforcing steel: minimum 400 MPa yield grade; deformed billet steel bars conforming to CAN/CSA-G30.18; plain finish.



## CONCRETE REINFORCEMENT

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### 2.2 Accessory Materials

- .1 Tie wire: minimum 1.6 mm annealed type, or patented system accepted by Contract Administrator.
- .2 Chairs, bolsters, bar supports, spacers: adequately sized for strength and support of reinforcing steel during construction.
- .3 Bar chairs to be non-corrosive PVC chairs or purpose made concrete chairs. Steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.
- .4 Side form spacers to be non-corrosive PVC spacers, purpose made. PVC chairs, steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.

### 3. EXECUTION

#### 3.1 Examination

- .1 Before starting this Work, examine Work done by others which affects this Work.
- .2 Notify the Contract Administrator of any conditions which would prejudice proper completion of this Work.
- .3 Commencement of Work implies acceptance of existing conditions.

#### 3.2 Fabrication

- .1 Fabricate reinforcing steel in accordance with CAN/CSA-A23.1-00 and Drawings.
- .2 Locate reinforcing splices not indicated on Drawings at points of minimum stress.
- .3 Fabricate within the following tolerances:
  - .1 Sheared length: +0, -25 mm
  - .2 Stirrups, ties, and spirals: +0, -10 mm
  - .3 Other bends: +0, -25 mm
- .4 All bending shall be done cold with a suitable machine accurately producing all lengths, depths and radii shown on the bending details.
- .5 After initial fabrication, reinforcing steel shall not be re-bent or straightened unless so indicated on the Drawings.
- .6 Heating of reinforcing steel will not be permitted.

## CONCRETE REINFORCEMENT

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### 3.3 Installation

- .1 Place reinforcing steel in accordance with reviewed placing Shop Drawings and CAN/CSA-A23.1-00. Chairs supporting slab reinforcing shall not be further apart than 1200 mm in either direction. Tie reinforcing steel at maximum 600 mm spacing.
- .2 Adequately support reinforcing and secure against displacement within tolerances permitted.
- .3 Place reinforcing steel to provide concrete cover required by CAN/CSA-A23.1-00, but not less than shown below or noted otherwise on the Drawings:
  - .1 Beam stirrups: 40 mm unless noted otherwise; main steel: 50 mm
  - .2 Slabs (top and bottom): 50 mm
  - .3 Column ties: 40 mm; main steel: 50 mm
  - .4 Walls: 50 mm on the non-liquid side, and 60 mm on the liquid side
  - .5 Concrete formed against earth (including bottom of slab on grade): 75 mm
- .4 Maintain alignment tolerances as follows:
  - .1 Slabs:  $\pm 5$  mm
  - .2 Other structural members:  $\pm 10$  mm
  - .3 Rebar bends and ends:  $\pm 50$  mm
- .5 Do not disturb or damage vapour barrier or void form while placing reinforcing steel.
- .6 Install purpose made highly visible protective safety caps on all exposed projecting bar ends.

### 3.4 Safety Protection for Reinforcing Ends

- .1 Highly visible protection safety caps shall be installed for all reinforcing ends immediately following placement of bars.
- .2 The protection caps shall be highly visible and shall be made secure so that accidental contact will not easily dislodge the caps. Dislodged caps shall be re-installed immediately.

### 3.5 Cleaning

- .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.

**END OF SECTION**

## CONCRETE ACCESSORIES

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### 1. GENERAL

#### 1.1 Work Included

- .1 Premoulded Joint Fillers
- .2 Resilient Filler
- .3 Backer Rods
- .4 Joint sealants
- .5 Vapour Barrier
- .6 PVC Waterstop
- .7 Expansive waterstop
- .8 Non-ferrous grout
- .9 Latex patching agent
- .10 Epoxy bonding agent
- .11 Curing and sealing compounds
- .12 Curing compound
- .13 Moisture retention film
- .14 Repair Mortar

#### 1.2 Qualifications

- .1 All waterstopping and sealant installations are to be done by an established firm having at least five years of proven, satisfactory experience in this trade and employing skilled personnel.
- .2 Submit proof of qualifications in writing to the Contract Administrator prior to commencement of Work.

### 2. PRODUCTS

#### 2.1 Materials

- .1 Pre-moulded expansion joint filler (for joints associated with slabs on grade such as pads at doors): asphalt impregnated vegetable or cane fibreboard, conforming to ASTM D1751, sizes indicated on Drawings, such as W. R. Meadows Sealtight Fibre Expansion Joint.

### CONCRETE ACCESSORIES

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- .2 Resilient Filler: conforming to ASTM D1752, sizes as indicated on Drawings, greater than ninety percent (>90 percent) recover after fifty percent (50 percent) compression; closed cell foam joint filler, such as W.R. Meadows Sealright Ceramar, and Sika Flexcell by Sika.
- .3 Backer Rod: closed cell vinyl foam.
- .4 Joint sealants for non liquid retaining areas: non-staining, non-sagging, grey two-part polysulphide liquid polymer base or a two-part polyurethane base such as Sikaflex 2c NS/SL or Vulkem 245 for horizontal and vertical joints with compatible primer as per sealant manufacturer's requirements.
- .5 Joint sealants for liquid retaining areas: non-staining, non-sagging, grey two-part, polyurethane elastomeric sealant shall be suitable for submerged service such as Sikaflex 2c NS/SL. Polysulphide sealants shall not be used
- .6 Vapour barrier: 0.15 mm clear polyethylene film, with self-adhesive polyethylene or polyvinylchloride tape for sealing joints. Vapour barrier to CAN/CGSB-51.34-M86.
- .7 PVC Waterstop: to conform to CGSB 41-6P-35M polyvinyl chloride, edges wire looped for tying. Acceptable product is Wirestop CR-9380 by Paul Murphy. Factory fabricated and tested PVC waterstop vertical and horizontal cross, L and T shaped junction sections are to be used.
- .8 Expansive Waterstop: SikaSwell S-2 by Sika and CS-231 Controlled Expansion Waterstop by ConSeal Concrete Sealants to be used at specific locations indicated on Drawings or as directed by the Contract Administrator.
- .9 Non-ferrous grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, minimum 35 MPa compressive strength.
- .10 Latex Patching Agent: Duraweld-C Latex Bonding Agent, or accepted alternate.
- .11 Epoxy Bonding Agent: Master Builders Concrete 1001 LPL, Dural Duralbond, Sikadur 32 HI-bond, or accepted alternate.
- .12 Curing and Sealing Compounds: conforming to ASTM C309, such as Master Builders Masterseal, Sika Florseal, or accepted alternate.
- .13 Curing Compound: conforming to ASTM C309.
- .14 Moisture Retention Film: Master Builders Confilm or accepted alternate.
- .15 Repair Mortar: Meadow-Crete H by W.R. Meadows or accepted alternate.

## CONCRETE ACCESSORIES

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### 3. EXECUTION

#### 3.1 Installation

- .1 Pre-installation conference for waterstopping and sealant products: Prior to installation of waterstopping and sealant products, conduct a meeting with applicator, installers of Work adjacent to or that penetrates the waterstop or sealant products, the Contract Administrator and manufacture's technical representative to review the following:
  - .1 General project requirements.
  - .2 Manufacture's product data sheets and installation guides.
  - .3 Substate conditions and procedures for substate preparation and product installations.
  - .4 The manufacture's technical representative is to issue reports to the Contract Administrator identifying that the substate conditions and installation procedures are being followed for each area where the specific product is being utilized.
  - .5 Responsibility and costs associated with verification and correlation of field dimensions, fabrication processes, techniques of construction, installation and coordination of Work and manufactures technical representative for all parts of the Work rests with the Contractor.
- .2 Install all concrete accessories in accordance with Drawings and manufacturer's recommendations and ensure compatibility. Install straight, level, and plumb.
- .3 Ensure items are not disturbed during concrete placement.
- .4 Curing and sealing compounds are to be used for curing purposes of all concrete where practical or compatible with finishes. Concrete slabs shall be moist cured as per Section 03300.
- .5 Joint sealant shall be applied per manufacturer's instructions. If joint surfaces are damp, dry the surfaces and apply primer as recommended by manufacturer. Apply polyethylene debonding tape as indicated on the Drawings.
- .6 Joint filler: install joint filler in expansion joints as indicated on Drawings.
- .7 PVC Waterstop
  - .1 Install PVC waterstop in all joints in a continuous and inter-connected manner for liquid retaining structures and containment unless indicated otherwise on the Drawings.
  - .2 All waterstop joints other than straight butt joints shall be factory fabricated and tested by the waterstop supplier. All field splices to be heat-fused and tested for complete seals by use of a corona discharge unit, costs for testing to paid for by Contractor.
  - .3 Install waterstop continuous without displacing reinforcement. Butt weld splices to manufacturer's directions. Secure in place to prevent dislodgment during placing of concrete.

### CONCRETE ACCESSORIES

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- .4 Take particular care to correctly position the waterstop during installation. Tie the waterstop adequately for support in accordance with manufacturer's instructions, but at spacings no greater than 300 mm to ensure proper embedment, symmetrical about the joint, and to prevent displacement during concrete placement. Fully compact the concrete in the region of the waterstop during the placing of the concrete.
- .5 Do not place concrete until waterstop has been reviewed by the Contract Administrator.
- .8 Expansive Waterstop
  - .1 Apply expansive waterstop where specifically indicated on the Drawings or as directed by the Contract Administrator.
  - .2 Prepare surfaces and apply beads sized to manufacturer's instructions.
  - .3 Protect expansive waterstop from contact with water prior to concrete placement. Replace waterstop if it has come in contact with water and has begun to absorb water.
- .9 Latex patching agent is to be used for patching formed concrete surfaces where required.
- .10 Repair Grout
  - .1 Apply repair grout where existing concrete is to be removed as indicated on the Drawings or as directed by the Contract Administrator.
  - .2 Prepare surfaces and apply repair mortar to manufacturer's instructions. Use pea gravel to extend the mixture in accordance with the manufacturer's instructions.
- .11 Vapour Barrier
  - .1 Provide vapour barrier below all slabs cast on void forms.
  - .2 Methanol Facility cast-in-place concrete: Provide vapour barrier below areas where specialty coatings for concrete are being applied as indicated on the Drawings.
  - .3 For all other exterior slabs on grade and exterior structural slabs vapour barrier is not required.

**END OF SECTION**

## CAST-IN-PLACE CONCRETE

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### **1. GENERAL**

#### **1.1 Work Included**

- .1 All plain and reinforced cast-in-place concrete shown on the Drawings
- .2 Setting anchors, inserts, frames, sleeves, and other items supplied by other Sections
- .3 Repairing concrete imperfections
- .4 Finishing formed concrete surfaces
- .5 Finishing slab surfaces
- .6 Curing of concrete

#### **1.2 Quality Assurance**

- .1 Cast-in-place concrete to conform to CAN/CSA-A23.1-00
- .2 Testing shall conform to CAN/CSA-A23.2-00
- .3 These standards shall be available in the Contractor's Site office for the use of the Contractor, Sub-contractors and Contract Administrator.

#### **1.3 Qualification**

- .1 Concrete flatwork finishing is to be done by an established firm having at least five years of proven, satisfactory experience in this trade and employing skilled personnel.
- .2 Submit proof of qualifications in writing to the Contract Administrator prior to commencement of Work.

#### **1.4 Inspection and Testing**

- .1 Notify the Contract Administrator at least 48 hours before complete formwork and concrete reinforcement is ready for review. Reinforcing in walls shall be reviewed prior to closing forms.
- .2 Allow ample time for notification, review, and corrective Work, if required, before scheduling concrete placement.
- .3 Concrete sampling, inspection, and testing is to be performed by a CSA certified inspection and testing firm appointed and paid for by the City.
- .4 Provide unencumbered access to all portions of Work and cooperate with appointed firm.
- .5 Submit proposed mix design of each class of concrete to the Contract Administrator for review.

**CAST-IN-PLACE CONCRETE**

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- .6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.
- .7 Notify the Contract Administrator and Concrete Testing Firm at least 24 hours in advance of any concrete placement.
- .8 A minimum of three (3) concrete test cylinders will be taken for every 50 or less cubic meters of each class of concrete placed. The Contract Administrator may increase the testing requirements as required to ensure concrete is in accordance with the Specification. Contractor to adjust scheduling of concrete as required allowing for testing as required by the Contract Administrator.
- .9 At least three test cylinders will be taken daily for each class of concrete placed.
- .10 One (1) slump test and one (1) air content test will be taken for each set of test cylinders taken.
- .11 Additional slump and air content tests may be taken as necessary to verify quality of concrete.
- .12 Repair all areas where concrete surfaces were tested.
- .13 Testing of concrete will be performed in accordance with CAN/CSA-A23.2-00. Test results will be issued to the Contractor, the Contract Administrator, and the City.
- .14 The Contractor is to pay costs for required retesting due to defective materials or workmanship.
- .15 If accepted by the Contract Administrator, the Contractor may arrange and pay for additional tests for use as evidence to expedite construction.
- .16 Strength requirements:
  - .1 To conform to the strength requirements of this Specification, the results of tests performed on laboratory cured cylinders for each class of concrete shall meet the requirements of Clause 17.6 of CAN/CSA-A23.1-00.
  - .2 If the strength requirements are not met the Contract Administrator shall have the right to require one or more of the following, all costs of which will be the responsibility of the Contractor:
    - .1 Changes in the mix proportions for the remainder of the Work.
    - .2 Additional curing on those portions of the structure represented by the test specimens that failed and cores drilled and tested in accordance with CAN/CSA-A23.2-00; the strengths shall be indicative of the strength of the in-place concrete.
    - .3 Load testing of the structural elements.



## CAST-IN-PLACE CONCRETE

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- .3 After the completion of the testing procedure, if the Contract Administrator is not satisfied with the indicated quality of the concrete, the Contractor may be required to strengthen or replace those portions which the Contract Administrator deems to be unsatisfactory.

## 2. PRODUCTS

### 2.1 Concrete Materials

- .1 Cement: Normal Type 10 and Type 50 Portland Cement conforming to CSA-A5.
- .2 Fine aggregate: conforming to Normal Density Fine Aggregate, CAN/CSA-23.1-00. If requested by the Contract Administrator, submit evidence at least two weeks before use in concrete mix showing conformance to normal Density Fine Aggregate, CAN/CSA-A23.1-00, Table 4 and Table 6.
- .3 Coarse aggregate: conforming to Normal Density Coarse Aggregate, CAN/CSA-23.1-00, Group I, 20-5 mm and 10 to 2.5 mm. If requested by the Contract Administrator, submit evidence at least two weeks before use in concrete mix showing conformance to normal Density Coarse Aggregate, CAN/CSA-A23.1-00, Table 5 and Table 6.
- .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 requested by the Contract Administrator.
- .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 C fly ash, conforming to CSA-A23.5, source of material to be acceptable to the Contract Administrator.

### 2.2 Admixtures

- .1 Air entrainment: conforming to ASTM Standard C260
- .2 Chemical admixtures: conforming to ASTM Standard C494
- .3 Calcium chloride or admixtures containing calcium chloride shall not be used in concrete.

### 2.3 Concrete Mixes

- .1 Pay all costs for mix design. Submit mix design to the Contract Administrator for review a minimum of four weeks prior to concrete casting.

## **CAST-IN-PLACE CONCRETE**

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- .2 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-00 and attached Table A (see below at end of this Section). The attached Table A requirements govern where there is a difference between Table A and CAN/CSA-A23.1-00, Tables 6 to 10 requirements.
- .3 Maximum allowable substitution of cement with fly ash material shall be 20 percent by weight when acceptable to the Contract Administrator.
- .4 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.
- .5 Use set-retarding admixtures during hot weather only when accepted by the Contract Administrator.
- .6 All admixtures must be compatible within the mix. Concrete with freezing and thawing exposure must satisfy the durability requirements of CAN/CSA-A23.1-00, Sections 14 and 15.
- .7 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 acceptance.
- .8 The water:cementing material ratio must be calculated and shown based on all available mixing water excluding aggregate absorption.
- .9 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 to cementitious material ratio.

### **3. EXECUTION**

#### **3.1 Examination**

- .1 Before starting this Work examine Work done by others which affects this Work.
- .2 Notify the Contract Administrator of any conditions that would prejudice proper completion of this Work.
- .3 Commencement of Work implies acceptance of existing conditions.

#### **3.2 Placing Concrete**

- .1 Place concrete in accordance with requirements of CAN/CSA-A23.1-00 and as indicated on the Drawings. Layout and accuracy of the Work is the Contractor's sole responsibility.
- .2 Notify the Contract Administrator a minimum of 24 hours prior to casting concrete. Under no circumstances cast concrete without notifying Contract Administrator, or in his absence, arranging for review of the Work and sampling of concrete.

### CAST-IN-PLACE CONCRETE

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- .3 The concrete shall be placed rapidly and evenly as near to its final position as possible to reduce the risk of segregation, flowlines, and cold joints. Concrete shall be placed within 1.5 hours of mixing.
- .4 Ensure all anchor bolts, seats, plates, and other items to be cast into concrete are securely placed and will not interfere with concrete placement.
- .5 Before placing concrete all equipment for transporting the concrete shall be cleaned of hardened concrete and foreign materials.
- .6 Immediately before concrete is placed, Contractor shall carefully inspect all forms to ensure that they are properly placed, sufficiently rigid and tight, and that embedded parts are in the correct position and secured against movement during the placing operation. All reinforcing steel and forms shall be thoroughly cleaned of hardened concrete and other foreign materials.
- .7 Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods, which will prevent the separation or loss of the ingredients. Concrete shall be deposited in the forms as nearly as practicable in its final position to avoid re-handling or flowing. Vibrators shall not be used to move concrete. Under no circumstances shall the concrete, which has partially hardened, be deposited in the forms.
- .8 Concrete shall be thoroughly compacted by mechanical vibrators during placing operations. It shall be thoroughly worked around the reinforcement, embedded fixtures, and into the corners of the forms.
- .9 Vibrate concrete using the appropriate size equipment as placing proceeds, in accordance with CAN/CSA-A23.1-00. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure.
- .10 Prepare set or existing concrete by removing all laitance and loose or unsound materials and apply bonding agent in accordance with manufacturer's recommendations.
- .11 Where placing operations would involve dropping the concrete more than 1500 mm, it shall be placed through canvas hoses or galvanized steel chutes. Concrete shall not be raised at a rate greater than that for which proper vibration may be achieved.
- .12 In locations where new concrete is dowelled to existing concrete, drill holes in existing concrete, insert dowels, and pack solidly with non-shrink grout.
- .13 A minimum of three days shall elapse between adjacent castings separated by construction joints or expansion joints.
- .14 Do not place concrete if carbon dioxide producing equipment has been in operation in the building during the 12 hours preceding the cast. This equipment shall not be used during placing or for 24 hours after placing. During placing and curing concrete, surfaces shall be protected by formwork or an impermeable membrane from direct exposure to carbon dioxide, combustion gases, or drying from heaters.

### CAST-IN-PLACE CONCRETE

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- .15 Honeycomb or embedded debris is not acceptable.
- .16 Remove and replace defective concrete.
- .17 Maintain accurate records of cast-in-place concrete items. Record date, location of cast, quantity, air temperature, and test samples taken.

### 3.3 Cold Weather Concreting

- .1 The requirements of this section shall be applied to all concreting operations if the mean daily temperature falls below 5°C during placing or curing.
- .2 Supplementary equipment is to be at the Site if concrete is likely to be placed in cold weather.
- .3 Formwork and reinforcing steel 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 days and be kept above freezing temperature for at least an additional seven 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 in the forms shall be within the range specified in CAN/CSA-A23.1-00 for the thickness of the section being placed.
- .6 When the mean daily temperature may fall below 5°C, a complete housing of the Work, together with supplementary heat, shall be provided.
- .7 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.
- .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 Refer to Section 01500 for temporary enclosure and heating requirements.
- .11 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 20°C at least 12 hours prior to the start of the concrete placing.

### CAST-IN-PLACE CONCRETE

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- .12 The Contractor shall supply all required heating apparatus and the necessary fuel. When dry heat is used, a means of maintaining atmospheric moisture shall be provided.
- .13 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.
- .14 The Contractor shall keep a curing record of each concrete casting. The curing record shall include date and location of the cast, 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.

#### 3.4 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 as quickly as possible to avoid "cold joints".
- .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. Mass concrete shall be water cured for the basic curing period when the air temperature is at or above 20°C, in order to minimize the temperature rise of the concrete.

## CAST-IN-PLACE CONCRETE

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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 it 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 3.4.5.2 of this specification Section, the formwork, 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 indicated below for the indicated size of the concrete section.
  - .1 Section thickness less than 300 mm: 10°C min, 27°C max.
  - .2 Section thickness 300 mm to 1000 mm: 10°C min, 27°C max.
  - .3 Section thickness greater than 1000 mm: 5°C min, 25°C max.

### .5 Protection from drying

#### .1 Moderate drying conditions

- .1 When surface moisture evaporation exceeds 0.75 kg/m<sup>2</sup>/h, windbreaks shall be erected around the sides of the structural element.

#### .2 Severe drying conditions

- .1 When surface moisture evaporation exceeds 1.0 kg/m<sup>2</sup>/h, 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.

#### .3 Surface moisture evaporation rate

- .1 The monograph, Figure D1, Appendix D of CAN/CSA-A23.1-00 shall be used to estimate surface moisture evaporation rates.

## CAST-IN-PLACE CONCRETE

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### 3.5 Concrete Protection for Reinforcement

- .1 Ensure reinforcement is placed to provide specified concrete cover in accordance with Section 03200.

### 3.6 Construction Tolerance

- .1 The Work shall be carefully and accurately set out; true to the positioning, levels, slopes, and dimensions shown on the Drawings to the tolerances indicated below:
  - .1 Sizes of member or thickness of slabs: +6 mm - 0 mm.
  - .2 Cover of concrete over reinforcement:  $\pm 3$  mm.
  - .3 Variations from plumb: 6 mm in 3.0 m, 10 mm maximum.
- .2 If these tolerances are exceeded the Contractor may, at the discretion of the Contract Administrator, be required to remove and replace or to modify 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.

### 3.7 Finishing Slab Surfaces

- .1 Finish all top slab surfaces conforming to CAN/CSA-A23.1-00, Clause 22 as indicated below:
  - .1 Main floors in the Blower and Exhaust Fan Buildings: Class A.
  - .2 Structural slabs of liquid retaining structures or containment areas: Maintain surface flatness of maximum 6 mm in 3 m. Bull float surface only.
  - .3 Methanol Facility structural slabs: Maintain surface flatness of maximum 6 mm in 3 m. Bull float and hand trowel using magnesium trowel unless noted. At area for specialty coating for concrete bull float only. Finish concrete slab to elevations indicated, less the allowance for the specialty coating thickness in areas indicated.
  - .4 Exterior slabs including Soda Ash Silo structural slabs: Maintain surface flatness of maximum 6 mm in 3 m. Bull float and hand trowel using magnesium trowel.
- .2 Bull floating
  - .1 Flatness for suspended concrete slabs to be achieved by means of hiway straight edge (minimum 3 m width) in lieu of standard bull float. Immediately after screeding, bull float floor surfaces to remove ridges and fill voids. Bull float air entrained concrete surfaces using magnesium bull float.
  - .2 Complete bull floating before any excess moisture or bleed water is visible on surface.

### CAST-IN-PLACE CONCRETE

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#### .3 Mechanical floating

- .1 Mechanical float floor surfaces when bleed water has disappeared and surfaces are sufficiently hard to prevent working excess mortar to surface.
- .2 Continue floating as necessary to produce surfaces of uniform texture, free from hollows, bumps, and screed marks.
- .3 For surfaces to be trowelled, continue floating as necessary to embed coarse aggregate particles firmly below surface mortar.
- .4 Hand float in restricted areas, corners, etc.

#### .4 Trowelling

- .1 Trowel non-air entrained concrete floor surfaces with mechanical trowelling machines fitted with steel blades. Hand trowel non-air entrained concrete with steel blades. Hand trowel entrained air concrete using magnesium blades.
- .2 Commence trowelling when surfaces are sufficiently hard to prevent working excess fine material to surface.
- .3 Perform additional trowelling at intervals so final trowelling is done just before concrete becomes so hard that further trowelling is ineffective.
- .4 Finish trowelled surfaces to be hard, dense, and free from blemishes and other imperfections.
- .5 Hand trowel in restricted areas, corners, around cast-in items, etc.
- .6 Cure concrete as specified.
- .7 Protect all floors from damage during construction.

### 3.8 Formed Concrete

- .1 Allow the Contract Administrator to review concrete surfaces immediately upon removal of the forms.
- .2 Any imperfect joints, voids, stone pockets, or other defective areas and tie holes, as specified, shall at once be patched before the concrete is thoroughly dry.
- .3 Modify or replace concrete not conforming to qualities, lines, details, and elevations specified herein or indicated on the Drawings.

### 3.9 Finishing Formed Surfaces

- .1 Formed vertical concrete surfaces:
  - .1 Formliner finish as indicated in Section 03100 on the exterior and interior of liquid or containment concrete surfaces.



### CAST-IN-PLACE CONCRETE

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- .2 Finish visible surfaces to Smooth Rubbed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.7.2.
- .3 Non visible surfaces to receive insulation and other coverings to be finished to Smooth-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.6.
- .4 Other non visible surfaces to be finished to Rough-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.5.

#### **3.10 Curing and Protection**

- .1 Cure and protect freshly placed concrete in accordance with Clause 21 of CAN/CSA-A23.1-00.
- .2 All concrete shall receive moist curing for a period of at least seven days. One 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 wet.
  - .2 Surface sealed with polyethylene sheeting at least 0.15 mm thick and the concrete kept thoroughly wet.
  - .3 Subject to the acceptance of the Contract Administrator or as specified, a liquid, membrane forming, curing compound supplied at the rate recommended by the manufacturer may be used. Curing compounds shall not be used on a surface where bond is required for the finishes.
  - .4 Surfaces of concrete that are protected by formwork left in place for seven days, shall not require any additional curing (except as specified for hot weather). If the formwork is removed in less than seven days, the concrete shall receive a moist curing as above or until seven days have elapsed since the concrete was placed, whichever occurs first.
- .3 No concrete placement 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.

#### **3.11 Concrete Toppings**

- .1 Place bonded toppings to thickness and elevations indicated on Drawings, in accordance with CAN/CSA-A23.1-00 unless noted.
- .2 Remove all laitance, dirt, dust, debris, grease and other substances from base slab.

### CAST-IN-PLACE CONCRETE

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- .3 Prepare the base slab profile to an ICRI (International Concrete Repair Institute) CSP-5 profile.
- .4 Saturate the base slab to an SSD (saturated surface dry) condition for a minimum of 24 hours prior to casting of the concrete topping.
- .5 Utilize a cement/sand grout in accordance with the requirements of Clause 23.4.2 in CAN/CSA-A23.1-00.
- .6 Tensile testing of the bonded topping will be preformed in accordance with CSA-A23.2-00.

#### **3.12 Patching**

- .1 Allow Contract Administrator to review concrete surfaces immediately upon removal of all formwork.
- .2 Patch imperfections when concrete is still green.
- .3 Remove all exposed metal form ties, nails and wires, break off fins, and remove all loose concrete.
- .4 Thoroughly wet all form tie holes and patch with patching mortar followed by proper curing.
- .5 Chip away honeycombed and other defective surfaces to a depth of not less than 40 mm with the edges straight and perpendicular to the surface. The area to be patched and a space at least 150 mm wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. Apply bonding agent to manufacturer's instructions and patch with patching mortar followed by proper curing.
- .6 The patch shall be made of the same material and of the same proportions as used for the concrete except that the coarse aggregate shall be omitted, and cement added to match the colour of the surrounding concrete. The amount of mixing water shall be as little as is consistent with the requirements.

#### **3.13 Equipment Pads, Pipe Supports, and Cast in Items**

- .1 Provide concrete pads and supports for equipment and pipes where and as indicated on Drawings. Adjust dimensions to reviewed equipment Shop Drawings.
- .2 Insert bolts and sleeves and pack solidly with non-shrink grout, in accordance with setting details and templates.
- .3 Trowel surface smooth. Chamfer visible horizontal and vertical edges.
- .4 Clean excess concrete from metal frames, inserts, weld plates, etc. Clean and tool concrete around the above noted items.

#### **3.14 Grouting**

- .1 Grout all miscellaneous anchor bolts with non-ferrous or epoxy grout as specified using templates for accurate positioning.

### CAST-IN-PLACE CONCRETE

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- .2 Grout between pipes and pipe supports as required to provide continuous support over the entire contact area.
- .3 Grout under base plates and other items as required and shown on the Drawings.
- .4 Grout dowels to existing concrete as indicated on the Drawings.

#### **3.15 Defective Concrete**

- .1 Concrete not meeting the requirements of the Specifications and Drawings shall be considered defective concrete.
- .2 Concrete not conforming to the lines, details, and grade specified herein or as shown on the Drawings shall be modified or replaced at the Contractor's expense. Finished lines, dimensions, and surfaces shall be correct and true within tolerances specified herein and in the Section 03100.
- .3 Concrete not properly placed resulting in honeycombing and other defects shall be repaired or replaced at the Contractor's expense.
- .4 The Contract Administrator shall have the right to require one or more of the following all of which will be at the Contractor's expense:
  - .1 Changes in mix proportions for the remainder of the Work.
  - .2 Cores drilled and tested from the areas in question as directed by the Contract Administrator and in accordance with CAN/CSA-A23.2-00. The test results shall be indicative of the strength of the in-place concrete.
  - .3 Load testing of the structural elements.

#### **3.16 Watertightness Testing**

- .1 All water retaining structures shall be watertight and all precautions shall be taken, especially joint treatment, to construct watertight structures.
- .2 Perform watertightness testing for all water retaining compartments. Watertightness testing shall be performed in accordance with ACI 350.1 Designation HST-100 except as described in the following clauses.
- .3 Notify the Contract Administrator at least two working days before commencing the watertightness test.
- .4 The structures, when full, shall be reviewed over a 48 hour period for leakage including monitoring of visible leaks and testing for leaks by measurement.
- .5 Filling the structures in preparation of the watertightness test shall be performed only after the wall and floor concrete have attained 100 percent of the design strength and the roof, where applicable, has obtained 75 percent of the design strength. Fill the tanks with clean water 48 hours prior to the watertightness test to allow for full saturation of the concrete.

### **CAST-IN-PLACE CONCRETE**

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- .6 All water used for testing and re-testing shall be supplied as described in Section 01500 - Temporary Facilities.
- .7 The Contractor shall cooperate with and assist the Contract Administrator with the leakage measurements during the next 48 hour period. With the water at maximum operating level for 48 hours, there shall be no visible moisture or wetness on areas that will be seen or backfilled and the leakage measured over a period of 24 hours shall not exceed 0.10 percent of the water volume in the test period.
- .8 Locate and repair all leaks until all leakage is remedied and repeat the 48 hour watertightness test following each repair operation, at no additional cost to the City.
- .9 All water used for testing and re-testing shall be supplied as described in Section 01500 - Temporary Facilities. Disposal of the water for all tests shall be at the Contractor's expense.

#### **3.17 Construction Joints**

- .1 Construction joint locations shall be as shown on the Drawings.
- .2 Joints not indicated on the Drawings shall be located so as to least impair the strength of the structure. The location of these joints shall be subject to prior review and acceptance by the Contract Administrator. Joints shall be in accordance with CAN/CSA-A23.1-00, or as indicated on the Drawings.
- .3 The surface of hardened concrete shall be thoroughly cleaned of foreign matter and laitance by sand blasting, and shall be thoroughly wetted with water, but not saturated, and the forms shall be re-tightened against the face of the hardened concrete before depositing additional concrete. Any concrete splatter on reinforcing bars shall be removed by sand blasting.

#### **3.18 Clean-Up**

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

**CAST-IN-PLACE CONCRETE**

**Table A**

Mix Type	Portion of Structure	Min. Compressive Strength @ 28 Days (MPa)	Cement Type	Min. Cementing Material Content (kg/m <sup>3</sup> )	Max. Water Cementing Material Ratio	Nominal Aggregate Size (mm)	Slump (mm)	Entrained Air Content (%)
1	Liquid retaining structural concrete or containment areas – structural slabs and walls.  Grade beams, concrete beams and columns within liquid retaining areas.  Class of exposure: C-1	35	50	335	0.40	20 to 5	65 ± 25	5 to 8
2	Non-liquid retaining or non containment structural concrete in contact with soil, backfill or exposed to weather – pile caps, grade beams, and exterior pads  Class of exposure: C-1	35	50	--	0.40	20 to 5	80 ± 20	5 to 8
3	Exterior miscellaneous concrete – curbs, equipment bases, pipe supports.  Class of exposure: C-2	32	50	--	0.45	20 to 5	80 ± 20	5 to 8
4	Interior structural concrete – slabs  Class of exposure: N	30	10	--	0.50	20 to 5	80 ± 20	Less than 3
5	Interior miscellaneous concrete – curbs, equipment bases, pipe supports, benching  Class of exposure: N	25	10	--	0.50	20 to 5	80 ± 20	Less than 3
6	Grout or Concrete used in Masonry infill	20	10	--	--	10 to 2.5	150 ± 30	Less than 3

**END OF SECTION**

## **PRECAST CONCRETE DECK**

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### **1. GENERAL**

#### **1.1 Work Included**

- .1 Supply and installation of double tee and hollow core deck slabs
- .2 Supply loose connecting and supporting devices
- .3 Sealant and back-up materials
- .4 Provide formed or cut openings for other Sections
- .5 Grouting of all connecting pockets
- .6 Final cleaning

#### **1.2 Design Requirements**

- .1 Design of precast concrete members and connections to conform to CSA A23.4 and PCI Design Handbook, under direct supervision of a registered Professional Engineer, fully experienced in design of precast concrete structural units.
- .2 Design all members and connections to safely support their own weight and all forces and loads to which they may be subjected.
- .3 Design connections to provide for building movement. Provide adjustable connections to accommodate misalignment of structure.
- .4 Design roof deck for a maximum live load deflection of  $1/240^{\text{th}}$  of the span unless noted otherwise.
- .5 Design roof deck within the Blower Room of the Blower Building for a maximum live load deflection of  $1/600^{\text{th}}$  of the span to suit the hoist system.

#### **1.3 Quality Assurance**

- .1 Fabricate and install precast concrete deck in accordance with requirements of CSA A23.4.
- .2 Maximum allowable manufacturing and erection tolerances are not to exceed those given in CSA 3-A23.4.

#### **1.4 Qualifications**

- .1 Manufacturer is to be certified for Prestressed Precast Concrete Products under CSA A251.

## PRECAST CONCRETE DECK

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### 1.5 Inspection and Testing

- .1 Inspection and testing is to be performed by a firm appointed and paid by the City. Notify Contract Administrator at commencement of shop work so inspection and testing may be scheduled for the appointed firm.
- .2 Provide free access to all portions of manufacturing plant and cooperate with appointed firm.
- .3 If requested by the Contract Administrator, submit proposed mix design for review prior to commencement of work.
- .4 Testing of cement and aggregates may be required to ensure conformance with requirements stated herein.
- .5 Testing of concrete will be performed in accordance with CSA A23.4.
- .6 If defects are revealed during testing of concrete and/or review of fabricated precast concrete deck members, Contract Administrator will request additional testing and/or review to ascertain full degree of defects.
- .7 Correct defects and/or irregularities to the satisfaction of Contract Administrator. Further testing and/or review, under similar conditions as earlier, will be performed. Pay all costs for retesting and additional review.
- .8 Test results will be issued to Contractor, Contract Administrator, and City.

### 1.6 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 01300 – Submittals, and CSA A23.4.
- .2 Prepare Shop Drawings under the seal of a Professional Engineer registered in the Province of Manitoba, fully experienced in design of precast concrete structural units.
- .3 Provide for Contract Administrator's review, copies of design calculations for reinforcing, hoisting, and connection and anchorage devices.
- .4 Clearly indicate product locations, fabrication details, unit identification marks, reinforcement, connection details, dimensions, erection support points, anchors and relationship to adjacent materials in sufficient detail to cover manufacture, handling, and erection.
- .5 Do not proceed with fabrication until Shop Drawings and design calculations have been reviewed by Contract Administrator.

### 1.7 Transportation, Handling, and Storage

- .1 Handle all precast members in a position consistent with their shape and design. Do all lifting and supporting only from support points indicated on Shop Drawings.

## **PRECAST CONCRETE DECK**

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- .2 Embedded lifting or handling devices are to be capable of supporting members in all positions anticipated during manufacture, storage, transportation, and erection. Maintain capacity of lifting devices sufficient to resist forces of minimum 2.5 times weight of member.
- .3 Deliver members to Site completely finished. Clearly mark members as indicated on Shop Drawings, with date of production and final position on structure.
- .4 Block and laterally brace members during transport and while stored on-site. Provide lateral bracing sufficient to prevent bowing and warping. Blocking and bracing shall be clean, non-staining, and shall facilitate uniform curing of exposed surfaces.
- .5 Provide edges of members with adequate protection to prevent staining, chipping, or spalling of concrete.

## **2. PRODUCTS**

### **2.1 Concrete Materials**

- .1 Cement: normal Portland cement Type 10, conforming to CAN/CSA-A5
- .2 Fine and Coarse Aggregates: conforming to CSA A23.4, from a single source for each type of aggregate for entire Work of this Section
- .3 Water: potable, free of deleterious matter that may interfere with finish, strength, and colour of concrete

### **2.2 Concrete Mix**

- .1 Concrete for double tees: exposure Class C-1
- .2 Concrete for hollow core: exposure Class N

### **2.3 Admixtures**

- .1 Air entrainment: conforming to ASTM Standard C260
- .2 Chemical admixtures: conforming to ASTM Standard C494

### **2.4 Reinforcement**

- .1 Reinforcing Steel: 400 MPa yield grade, deformed billet steel bars conforming to CAN/CSA G30.18 plain finish.
- .2 Reinforcing Wire: 480 MPa yield grade, deformed steel wire, conforming to ASTM A496, plain finish.



## PRECAST CONCRETE DECK

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- .3 Welded Steel Wire Fabric: plain type conforming to ASTM A185, plain finish. After fabrication, the welded steel wire fabric shall be hot dipped galvanized. Galvanizing to conform to CAN/CSA-G164; minimum 610 g/m<sup>2</sup>.
- .4 Prestressing Tendons: uncoated seven-wire, stress relieved strand, conforming to CSA G-279.

### 2.5 Hardware

- .1 Connections, Supporting Devices: Type W minimum Grade 300 MPa steel, conforming to CAN/CSA G40.21, all galvanized to CSA G164, 610 g/m<sup>2</sup> min. zinc coating after fabrication. Clean all members receiving galvanizing material to SSPC SP SP-10 "Near-White Blast Cleaning."
- .2 Bolts, Nuts and Washers: conforming to ASTM A325, hot dipped galvanized.
- .3 Anchors, Inserts: patented, load-tested galvanized steel.
- .4 Welding Materials: conforming to CSA W48 Series, to match material being welded. No welding of reinforcing steel will be allowed.

### 2.6 Prime Paint

- .1 Touch-up Primer: zinc dust/zinc oxide alkyd type, conforming to CGSB 1-GP-178.

### 2.7 Fabrication

- .1 Maintain plant records and quality control program during the production of precast structural concrete, as required by CSA A251, Appendix D. Make records available to Contract Administrator upon request.
- .2 Use forms and beds that are rigid, adequate to withstand prestressing forces and constructed of materials that will result in finished products conforming to requirements stated herein and on Drawings.
- .3 Establish concrete mix design by tests on trial batches to achieve required strengths. Maintain water content as constant as possible during manufacture.
- .4 Provide concrete protection of reinforcement in accordance with CSA A23.4. For double tees provide protection for continuous wet service.
- .5 Deposit and vibrate concrete to ensure proper consolidation, elimination of unintentional cold joints, and to minimize entrapped air on surfaces.
- .6 Fabricate all required connecting devices, plates, angles, inserts, bolts, and accessories.
- .7 Provide anchors and inserts to support loads for other trades sized and located as shown on Drawings.

## **PRECAST CONCRETE DECK**

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- .8 Perform shop welding of connecting and supporting devices in accordance with requirements of CSA W59.
- .9 Ensure anchors, inserts, plates, angles, and other cast-in items are accurately located. Maintain in position while concrete is placed and consolidated.
- .10 Coordinate with other trades for required holes through stems on double tee deck slabs to accommodate hangers.

### **2.8 Finish**

- .1 Finish deck slabs to conform to requirements of CSA A23.4 for installation of roofing systems.
- .2 Broom finish top surface of deck slabs shown to receive concrete topping.

## **3. EXECUTION**

### **3.1 Erection**

- .1 Provide temporary bracing for all stresses and induced loads during erection. Maintain temporary bracing in place until final support is provided.
- .2 Provide all hoisting equipment and operate in accordance with all applicable safety regulations.
- .3 Discontinue Work and advise Contract Administrator when members require adjustment beyond design criteria. Perform required modifications at no cost to the City.
- .4 Erect members without damage to shape or finish. Replace or repair damaged members to satisfaction of Contract Administrator, at no cost to the City.
- .5 Erect all units level, plumb, square, and true within allowable tolerances.
- .6 Securely fasten units in place.
- .7 Perform welding of connecting and supporting devices in accordance with requirements of CSA W59.
- .8 Prime paint field welds and touch up scratched and damaged galvanized surfaces.
- .9 Grout differential camber over 6 mm between tops of adjacent roof deck slabs with 1:3 mixture of cement and sand. Trowel and feather grout to smooth slope, not exceeding 1:12.
- .10 Fill all joints and grout keys between hollow core slabs with 1:3 mixture of cement and sand, trowel smooth.

**PRECAST CONCRETE DECK**

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- .11 Remove all grout from underside of hollow core slabs and walls and floors immediately after grouting.
- .12 Grout all erection pockets upon completion of erection.

**3.2 Cleaning**

- .1 Clean all exposed precast concrete surfaces and clean all surfaces with spilled or splattered from grouting operations.
- .2 Wash and rinse surfaces in accordance with precast manufacturer's recommendations. Do not use cleaning solutions that will harm surface finishes and other adjacent construction (concrete, masonry, steel, aluminum, glass, and any other adjacent surfaces).

**END OF SECTION**

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**PRECAST PARKING CURBS**

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**1. GENERAL**

**1.1 Work Included**

- .1 This Specification covers the supply and installation of precast concrete parking curbs.

**2. PRODUCTS**

**2.1 Materials**

- .1 Precast concrete parking curbs will be “Barkman Concrete Parking Bumper Curb” or approved equal, complete with hold-down pins.

**3. EXECUTION**

**3.1 Installation**

- .1 Install precast parking curbs at locations as shown on the Drawings.

**END OF SECTION**