

## CONCRETE FORMWORK

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### 1. GENERAL

#### 1.1 Work Included

- .1 Forms for all concrete and supporting falsework design
- .2 Wood or steel forms for all cast-in-place concrete
- .3 Void forms between structural elements and soil below
- .4 Shoring, bracing, and anchorage
- .5 Form openings for other trades
- .6 Coordinate installation of concrete accessories
- .7 Set anchor bolts, anchors, sleeves, frames, and other items supplied by other trades
- .8 Clean erected formwork prior to concrete placement
- .9 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-A23.1-04, CSA S269.1, ACI 347 and applicable construction safety regulations for the place of Work.
- .2 Design to be done 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-A23.1-04, CSA S269.1, ACI 347 and all applicable construction safety regulations for the place of Work.

#### 1.4 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 01300.
- .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.
- .4 Formwork, falsework and reshoring are to be reviewed by the same Professional Engineer prior to each concrete pour.

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- .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 T&G 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 Void Forms: Under structural slabs, provide Geovoid expanded polystyrene as manufactured by Plast-Fab; structurally sufficient to support weight of wet concrete mix until initial set; thickness as indicated on the Drawings. Under grade beams, pile caps provide Geospan, expanded polystyrene as manufactured by Plast-Fab structurally sufficient to support weight of wet concrete mix until initial set; thickness as indicated on the Drawings.

#### 2.5 Accessories

- .1 Form Ties: snap-off metal type, galvanized, fixed length; minimum working strength of 13 kN when assembled; free of defects that will leave holes deeper than 25 mm from concrete surface. Use plastic cone snap type or screw type on exposed surfaces. Wire ties are not permitted.
- .2 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.

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- .3 Corner or Chamfer Fillets: mill finished pine, 25 mm width, maximum possible lengths, mitre ends.

### 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 as necessary.
- .5 Obtain the Contract Administrator's permission for use of earth forms. When using earth forms, hand-trim sides and bottoms and remove loose material prior to placing concrete.
- .6 Arrange forms to allow removal without removal of principal shores, where these are required to remain in place.
- .7 Obtain the Contract Administrator's acceptance before framing openings in concrete slabs, beams, and columns not indicated on Drawings.
- .8 Provide falsework to ensure stability of formwork. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.
- .9 Position form joints to suit any expressed lines required in exposed concrete.
- .10 Provide 25 mm chamfer on all internal and external corners and edges of exposed concrete unless shown otherwise.
- .11 Form chases, slots, openings, drips and recesses as detailed on Drawings.

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- .12 Set screeds with top edge level to required elevations.
- .13 Check and readjust formwork to required lines and levels during placing of concrete.
- .14 Where construction joints are required in beams and suspended slabs, form joints at the one third point in the span unless shown or noted otherwise on Drawings. Form key between reinforcing bars.
- .15 Provide reveal or reglet on one side of construction joints on exposed surfaces as shown on the Drawings.

### 3.3 Tolerance

- .1 Construct formwork to produce concrete with dimensions, lines and levels within tolerances specified in CAN/CSA-A23.1-04, ACI 347.
- .2 Camber slabs and beams 6mm per 3 m of span unless otherwise indicated on Drawings. Review method of providing camber with the Contract Administrator prior to proceeding. Maintain beam depth and slab thickness from cambered surface.

### 3.4 Inserts/Embedded Items/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 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 review. Locate openings at bottom of forms to allow flushing water to drain.
- .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 the Contract Administrator when formwork is complete and has been cleaned, to allow for review. The Contract Administrator's review will be for verification that earth bottoms are clean, that forms are clean, and free from debris.

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- .3 For all exposed concrete surfaces, do not re-use wood type formwork more than two times. Do not patch formwork.

### 3.6 Cleaning

- .1 Clean forms as erection proceeds, to remove foreign matter. Remove cuttings, shavings and debris from within forms. Flush completely with water to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- .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 that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces moist prior to placing concrete.

### 3.8 Form Removal

- .1 Notify the Contract Administrator prior to removing formwork.
- .2 Do not remove forms and falsework until concrete has gained sufficient strength to carry its own weight, plus construction loads and design loads which are liable to be imposed. Verify strength of concrete by compression tests to satisfaction of the Contract Administrator.
- .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 and spacers for reinforcing.
- .3 Special support chairs, spacers, bar supports and bolsters for reinforcing where adjacent to architectural concrete surfaces.

#### **1.2 Quality Assurance**

- .1 Perform concrete reinforcing Work in accordance with CAN/CSA-A23.1-04
- .2 Perform welding in accordance with CSA W186

#### **1.3 Inspection and Testing**

- .1 If requested by the 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 General Specifications.
- .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 to conform to CAN/CSA-A23.1-04, CAN/CSA-A23.3-04 and RSIC's 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-A23.1-04 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.

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### 2. PRODUCTS

#### 2.1 Reinforcing Materials

- .1 Reinforcing Steel: 400 MPa yield grade; deformed billet steel bars conforming to CSA G30.18; plain finish.
- .2 Column Ties, Stirrups: 300 MPa yield grade; deformed billet steel bars, conforming to CSA G30.18; plain finish.

#### 2.2 Accessory Materials

- .1 Tie Wire: minimum 1.6 mm annealed type
- .2 Chairs, Bolsters, Bar Supports, Spacers: adequately sized for strength and support of reinforcing steel during construction.
- .3 Bars for surfaces exposed to view: to be non-corrosive PVC chairs or concrete chairs purpose made. Steel bar chairs, galvanized bar chairs, concrete brick, broken concrete block, or wood supports are not acceptable.
- .4 Bars for surfaces not exposed to view: PVC chairs, steel bar chairs, and galvanized bar chairs are acceptable; concrete bricks are acceptable for support of bottom layer of bars for slabs on fill. Broken concrete blocks, stones, and 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-A23.1-04, 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

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- .3 Other bends: +0, -25 mm
- .4 Weld reinforcing bars in accordance with CSA W186.
- .5 All bending shall be done cold with a suitable machine accurately producing all lengths, depths and radii shown on the bending details.
- .6 After initial fabrication, reinforcing steel shall not be rebent or straightened unless so indicated on the Drawings.
- .7 Heating of reinforcing steel will not be permitted.

### 3.3 Installation

- .1 Place reinforcing steel in accordance with reviewed placing Drawings and CAN/CSA-A23.1-04. Chair slab reinforcing not further apart than 1.2 m in either direction. Tie reinforcing steel at maximum spacing 600 mm.
- .2 Adequately support reinforcing, and secure against displacement within tolerances permitted.
- .3 Place reinforcing steel to provide concrete cover required by CAN/CSA-A23.1-04, but not less than shown below or indicated on the Drawings.
- .4 Place reinforcing steel to provide concrete cover as follows:

Item	Coverage (mm)
Beam Stirrups	40
Supported Slabs – exposed to dry interior	20
Supported Slabs – exposed to weather or void form	50
Column Ties	40
Walls (Interior)	25
Walls (exposed to weather or backfill)	50
Footings and concrete formed against earth	75
Slabs on fill	50

- .5 Maintain alignment tolerances as follows:

Item	Tolerances Plus or Minus
Slabs	5 mm
Other Structural Members	10 mm
Rebar Bends and Ends	50 mm

- .6 Do not disturb or damage vapour barrier or void form while placing reinforcing steel.



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- .7 Install purpose made highly visible protective safety caps on all exposed projecting bar ends.

**3.4 Cleaning**

- .1 Ensure concrete reinforcing is clean and free from oil and deleterious matter.
- .2 Remove all loose scale, loose rust and other deleterious matter from surfaces of reinforcing.

**END OF SECTION**

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## CONCRETE ACCESSORIES

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### 1. GENERAL

#### 1.1 Work Included

- .1 Curing and sealing compounds
- .2 Joint sealants
- .3 Joint fillers
- .4 Epoxy grout
- .5 Non-ferrous grout
- .6 Latex patching agent
- .7 Epoxy bonding agent
- .8 Moisture retention film
- .9 Vapour barrier under floor slabs on fill and on void form
- .10 Fasteners

#### 1.2 Submissions

- .1 Submit Shop Drawings consisting of information data sheets for all products proposed to be used in this project in accordance with General Specifications.
- .2 Clearly indicate profiles, sizes, materials, finishes, attachment devices, and installation details and any other applicable information.

### 2. PRODUCTS

#### 2.1 Prefabricated Construction and Control Joints

- .1 Curing and Sealing Compounds: Master Builders Masterseal and Sika Florseal, conforming to ASTM C309.
- .2 Joints Sealants: 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.
- .3 Joint Filler: closed cell polyurethane.
- .4 Epoxy Grout: Sika Talygrout, CPD Epoxy grout.

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- .5 Non-ferrous Grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-shrink grout, Steel C1 Grout, minimum 35MPa compressive strength.
- .6 Latex Patching Agent: Daraweld-C latex bonding agent.
- .7 Epoxy Bonding Agent: Master Builders Concreative 1001 LPL, Dural Duralbond, Sikadur 32 Hi-bond.
- .8 Moisture Retention Film: Master Builders Confilm.
- .9 Vapour Barrier: 0.25 mm clear polyethylene film, with self-adhesive polyethylene tape for joints, suitable for use below grade.
- .10 Fasteners: fasteners (all nuts, bolts, washers, screws, etc.) stainless steel for all aluminum items, conforming to ASTM 304 or 316, sizes and locations as required by item manufacturer.

### 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 Installation

- .1 Coordinate Work of this Section with other construction.
- .2 Install all concrete accessories in accordance with Drawings and manufacturer's recommendations; straight, level, and plumb.
- .3 Install vapour barrier on void forms under interior and exterior floor slabs on fill. Wrap top and sides only of void form; lap joints 150 mm minimum and tape full length of joints. Do not damage void forms.
- .4 Unless shown otherwise, place construction joints as shown on Drawings. Construction joints not shown on the Drawings shall be reviewed by the Contract Administrator.
- .5 Curing and sealing compounds are to be used for curing purposes of all concrete where practical or compatible with finishes.

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- .6 Joint sealant shall be applied per manufacturer's instructions. If joint surfaces are damp, dry and apply primer as recommended by manufacturer. Apply polyethylene debonding tape as indicated on the Drawings.
- .7 Joint Filler: install joint filler in expansion joints as indicated on Drawings.
- .8 Latex Patching Agent is to be used for patching formed concrete surfaces where required.
- .9 Epoxy Bonding Agent is to be used to bond new concrete to existing concrete surfaces.
- .10 Ensure embedded items are not disturbed during concrete placement.
- .11 When installing sealants, clean contact surfaces free from dirt, water, oil, rust, frost, and any other loose foreign matter. When recommended by manufacturer, prime contact surfaces of concrete.

**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 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-A23.1-04
- .2 Testing shall conform to CAN/CSA-A23.2-04
- .3 These standards shall be available in the Contractor's Site office for reference by the Contractor, subtrades, and the 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. Submit proof of qualifications in writing to the Contract Administrator.
- .2 Concrete shall be supplied from a batch plant meeting the certification requirements of the Manitoba Ready Mix Concrete Association. Submit proof of certification in writing to the Contract Administrator.

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

- .1 Notify the Contract Administrator at least 48 hours before complete formwork and concrete reinforcement will be ready for review.
- .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 the Contract Administrator.
- .4 Provide unencumbered access to all portions of Work and cooperate with appointed firm.

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- .5 Submit proposed mix design of each class of concrete to the Contract Administrator for review two weeks prior to commencement of Work.
- .6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.
- .7 Notify the Contract Administrator before placing concrete, in ample time to permit scheduling.
- .8 Three (3) concrete test cylinders will be taken for every 50 m<sup>3</sup> or less of each class of concrete placed.
- .9 At least three (3) test cylinders will be taken daily for each class of concrete placed.
- .10 Additional test cylinders will be taken during cold weather concreting and will be cured on jobsite under same conditions as concrete it represents.
- .11 One (1) slump test and one (1) air content test will be taken for each set of test cylinders taken.
- .12 Additional slump tests may be taken as necessary to verify quality of concrete.
- .13 Testing of concrete will be performed in accordance with CAN/CSA-A23.2-04. Test results will be issued to the Contractor and the Contract Administrator.
- .14 Pay costs for retesting required due to defective materials or workmanship.
- .15 Contractor may arrange and pay for additional tests for use as evidence to expedite construction.

## **2. PRODUCTS**

### **2.1 Concrete Materials**

- .1 Cement: normal Type GU and Type HS Portland cement conforming to CAN/CSA-A3000.
- .2 Fine Aggregate: conforming to Normal Density Fine Aggregate, CAN/CSA-A23.1-04. 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-A23.1-04, Table 10 and Table 12.
- .3 Coarse Aggregate: conforming to Normal Density Coarse Aggregate, CAN/CSA-A23.1-04, Group I, 20 - 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-A23.1-04, Table 11 and Table 12.

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- .4 Coarse Aggregate for Toppings: conforming to Normal Density Coarse Aggregate, CAN/CSA-A23.1-04, Group I, 10 - 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-A23.1-04, Table 11 and Table 12.
- .5 Ensure that no aggregates are used which may undergo volume change due to alkali reactivity, moisture retention or other causes. Confirm suitability of aggregate with a petrographic analysis if deemed necessary by the Contract Administrator.
- .6 Water: potable, clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.
- .7 Materials are to be obtained from the same source of supply or manufacture for the duration of the project.
- .8 Pozzolans: Type C fly ash, conforming to CAN/CSA-A23.5, source of material to be acceptable to the Contract Administrator.

### **2.2 Admixtures**

- .1 Air Entrainment: conforming to ASTM C260
- .2 Water Reducing Agent, Superplasticizer, and general chemical admixtures: conforming to ASTM C494
- .3 Calcium chloride or admixtures containing calcium chloride shall not be used in concrete.

### **2.3 Accessories**

- .1 Epoxy Bonding Agent: two component epoxy resin, Sika Sikadur Hi-Mod, Concrete Chemicals 901B, Allied Coatings AC 01201 Epoxy Bonding Agent
- .2 Non-Ferrous Grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non Shrink Grout, Steel CI Grout, minimum 35 MPa compressive strength
- .3 Curing Compound: for exterior slabs, walks, curbs conforming to ASTM C309 Type 1 - clear or translucent

### **2.4 Concrete Mixes**

- .1 Pay all costs for mix design. Submit design of a proven mix to the Contract Administrator for review a minimum of two weeks prior to concrete pour.
- .2 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-04.
- .3 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-04 and Table A (see below in this section). Table A requirements shall govern where there is a difference between Table A and CAN/CSA-A23.1-04 Tables 2 to 5 requirements.

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- .4 Flyash up to a maximum of 20% of the cement content by weight may be used when acceptable to the Contract Administrator.
- .5 Use accelerating admixtures in cold weather only when acceptable to the Contract Administrator. If accepted, the use of admixtures will not relax cold weather placement requirements. Do not use calcium chloride.
- .6 Use set-retarding admixtures during hot weather only when acceptable to the Contract Administrator.
- .7 All admixtures are subject to the acceptance by the Contract Administrator. List all proposed admixtures in mix design submission. Do not change or add admixtures to accepted design mixes without the Contract Administrator's review and acceptance.
- .8 All admixtures must be compatible within the mix. Concrete with freezing and thawing exposure must satisfy the durability requirements of CAN/CSA-A23.1-04, Section 8.
- .9 The water-cement ratio must be calculated and shown based on all available mixing water excluding aggregate absorption.
- .10 Concrete delivered to Site must be accomplished by a delivery slip indicating time of completion of mixing, design strength of concrete, air content and actual water-cement ratio.

Mix Type	Portion of Structure	Min. Compressive Strength @ 28 Days (MPa)	Exposure Class	Cement Type	Max. Water Cement Ratio	Nominal Aggregate Size (mm)	Slump (mm) Max./Min .	Air Content (%)
1.	Exterior structural concrete in contact with soil or exposed to weather – grade beams, pile caps, exterior pads on grade, curbs	35	C1, S1	HS	0.40	20 to 5	80 ± 30	4 to 7
2.	Cast-in-place piles	35	C1,S1	HS	0.40	40 to 5	80 ± 30	--
3.	Stabilized fill concrete	10	N	GU	--	Max. 40	--	--

**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.



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### 3.2 Placing Concrete

- .1 Place concrete in accordance with requirements of CAN/CSA-A23.1-04, and as indicated on Drawings. Layout of the Work and accuracy of same is the Contractor's sole responsibility.
- .2 Handling equipment shall be kept free from hardened concrete or foreign material, and cleaned at frequent intervals.
- .3 Notify the Contract Administrator a minimum 48 hours prior to commencement of concrete operations. Under no circumstances pour concrete without notifying the Contract Administrator, or in his absence, arranging for review of Work and sampling of concrete.
- .4 Ensure all anchors, bolts, seats, plates and other items to be cast into concrete are securely placed, and will not interfere with concrete placement.
- .5 Maintain accurate records of cast-in-place concrete items. Record date, location of pour, quantity, air temperature and test samples taken.
- .6 Ensure reinforcement, inserts, embedded parts, and formed expansion and control joints are not disturbed during concrete placement.
- .7 Prepare set concrete by removing all laitance and loose materials and applying bonding agent. Apply bonding agent in accordance with manufacturer's recommendations.
- .8 Place concrete continuously between present construction and control joints.
- .9 Vibrate concrete using the appropriate size equipment as placing proceeds in strict accordance with Clause 7.2.5.2 of CAN/CSA-A23.1-04. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure.
- .10 In locations where new concrete is dowelled to existing Work, drill holes in existing concrete, insert steel dowels and pack solidly with non-shrink grout.
- .11 Do not place concrete if carbon dioxide producing equipment has been in operation in the building during the 12 hours preceding the pour. 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.
- .12 Where placing operations would involve dropping the concrete more than 1500 mm, it shall be placed through canvas hoses or galvanized iron chutes. Concrete shall not be raised at a rate greater than that for which proper vibration may be affected.
- .13 A minimum of three days shall elapse between adjacent pours separated by construction joints or expansion joints.
- .14 Honeycomb or embedded debris in concrete is not acceptable.

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- .15 Remove and replace defective concrete.

### 3.3 Cold Weather Concreting

- .1 The requirements of this Section shall be applied to all concreting operations during cold weather, i.e., if the mean daily temperature falls below 5°C during placing or curing.
- .2 Supplementary equipment as required below shall be at the jobsite 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. The concrete shall be kept above freezing temperature for at least a period of 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-A23.1-04 for the thickness of the section being placed.
- .6 Combustion-type heaters may be used if their exhaust gases are vented outside the enclosures and not allowed to come into contact with concrete surfaces. Fire extinguishers must be readily at hand wherever combustion-type heaters are used.
- .7 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.
- .8 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.
- .9 When the mean daily temperature may fall below 5°C, a complete housing of the Work shall be provided:
  - .1 Provide all temporary enclosures and heating required during construction for concrete Work during cold weather including formwork, reinforcing steel installation, concrete placement, concrete curing, attendants, maintenance, and fuel. The Contractor shall maintain temperatures of minimum 10°C in the temporary facilities, unless indicated otherwise. Properly ventilate all heated areas.
  - .2 Pay for all costs in maintaining and providing temporary heat to the temporary facilities.

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- .3 Be responsible for any damages to the Work due to failure in providing adequate heat and protection during construction.
- .10 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.
- .11 The Contractor shall supply all required heating apparatuses and the necessary fuel. When dry heat is used, a means of maintaining atmospheric moisture shall be provided.
- .12 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.
- .13 The Contractor shall keep a curing record of each concrete pour. The curing record shall include date and location of the pour, mean daily temperature, temperatures above and below the concrete within the enclosures, temperatures of the concrete surface at several points, and notes regarding the type of heating, enclosure, unusual weather conditions, etc. This record shall be available for review by the Contract Administrator at all times, and shall be turned over to the Contract Administrator at the end of the concreting operations.

### 3.4 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.

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### .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.

### .3 Job Preparation

- .1 When the air temperature is at or above 25°C, or when there is the probability of its rising to 25°C during the placing period, facilities shall be provided for protection of the concrete in place from the effects of hot and/or drying weather conditions. Under severe drying conditions, as defined in Clause 3.4.5.2 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 that shown below for the indicated size of the concrete section.

Thickness of Section (m)	Temperatures (°C)	
	Minimum	Maximum
less than 0.3	10	27
0.3 – 1	10	27
1.2	5	25

### .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.

## CAST-IN-PLACE CONCRETE

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- .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-A23.1-04 shall be used to estimate surface moisture evaporation rates.

### 3.5 Concrete Protection for Reinforcement

- .1 Ensure reinforcement is placed to provide minimum concrete cover in accordance with CAN/CSA-A23.1-04 and Section 03200.
- .2 Where fire endurance is required, concrete cover is to conform to the National Building Code.

### 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 to 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-A23.1-04, Clause 7.5 as indicated below:
  - .1 Exterior slabs: maintain surface flatness of maximum 6 mm in 3 m; nonslip surface by brooming immediately after first trowelling; curing may be either curing compound or wet burlap covered with polyethylene sheeting.
- .2 Screeding
  - .1 Screed slabs in accordance with CAN/CSA-A23.1-04.

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### .3 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.

### .4 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.

### .5 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 trowel.
- .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 Conduits and Pipes

- .1 Conduit and pipe embedded in concrete shall be of a material not harmful to the concrete and shall:

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- .1 Not displace more than 4% of the area of the cross section of a column on which stress is calculated, including the area of concrete displaced by the bending of the conduit or exit path of the conduit out of the column.
- .2 Not exceed 1/3 the solid portion of the slab thickness.
- .3 Not be spaced closer than three diametres on centre.
- .4 Have a concrete covering of not less than 25 mm.
- .5 Be so installed that it will not require cutting, bending or displacement of the reinforcement or impair the structural strength of the system.

### 3.9 Install Items Specified Under Other Sections

- .1 Install hangers, sleeves, anchors, etc. specified under other Sections.
- .2 Pour concrete after other trades have satisfactorily installed their materials.
- .3 Do not eliminate or displace reinforcement to accommodate hardware. If hangers, inserts, anchors, etc. cannot be located as specified obtain acceptance of all modifications from the Contract Administrator before placing concrete.

### 3.10 Slabs on Fill

- .1 Seal punctures and damaged areas of vapour barrier before placing concrete. Use vapour barrier material, lapped over punctures and damaged areas minimum 150 mm in all directions. Seal with tape.
- .2 Place adjustable screeds at suitable locations. Do not pierce vapour barrier.
- .3 Carefully place concrete to required elevations indicated on Drawings.
- .4 Separate slabs-on-fill from vertical surfaces with 13 mm thick joint filler. Extend joint filler from bottom of slab to within 13 mm of finished surface. Refer to Section 03250 for joint filler requirements.
- .5 Place floor slabs in checkerboard or strip pattern indicated on Drawings.
- .6 Saw cut control joints in straight lines, with true, square edges, within 24 hours after finishing. Cut in pattern shown on Drawings. Use 5 mm thick blade, cut 1/3 depth of slab.

### 3.11 Equipment Pads

- .1 Provide concrete pads for equipment where and as indicated on Drawings. Adjust dimensions of pads to reviewed Shop Drawings.

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- .2 Insert bolts and sleeves and pack solidly with non-shrink grout, in accordance with setting details and templates.
- .3 Steel trowel surface smooth. Chamfer exposed vertical and horizontal edges.
- .4 Clean excess concrete from metal frames, inserts, weld plates, etc. Clean and tool concrete around the above noted items.

### **3.12 Curing and Protection**

- .1 Cure and protect freshly placed concrete in accordance with Clause 7.4 of CAN/CSA-A23.1-04.
- .2 Wet cure flat slabs and floors shown to receive toppings.
- .3 All concrete shall receive moist curing for a period of 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 6 mil thick and the concrete kept thoroughly wet.
  - .3 Subject to acceptance by the Contract Administrator, a liquid membrane forming, curing compound, supplied at the rate recommended by the manufacturer, may be used. Membrane to remain intact during the curing period. Curing compounds shall not be used on a surface where bond is required for additional concrete or other finishes.
- .4 Surfaces of concrete which are protected by formwork which is 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 moist curing as above until seven days have elapsed since the concrete was placed.
- .5 No concreting will be allowed until all materials required for the curing phase are on-site and ready for use.

### **3.13 Formed Concrete and Patching**

- .1 Allow the Contract Administrator to review concrete surfaces immediately upon removal of forms.
- .2 Remove all exposed metal form ties, nails and wires, break off fins and remove all loose concrete.
- .3 Treat imperfections (imperfect joints, voids, stone pockets, honeycomb, tie holes, etc.) in formed surfaces in accordance with CAN/CSA-A23.1-04 and to the Contract Administrator's satisfaction. Defective areas shall be chipped away to a depth of not less than 40 mm with the edges perpendicular to the surface. The area to be patched and a space at least 150 mm



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wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar.

- .4 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.
- .5 Modify or replace concrete not conforming to qualities, lines, details and elevations specified herein or indicated on Drawings, and to the acceptance of the Contract Administrator.

### 3.14 Finishing Formed Surfaces

- .1 Interior formed concrete surfaces:
  - .1 Finish exposed surfaces to Smooth Rubbed Finish conforming to CAN/CSA-A23.1-04, Clause 7.7.3.7.2
  - .2 Finish non-exposed surfaces to Rough-Formed Finish conforming to CAN/CSA-A23.1-04, Clause 7.7.3.5
- .2 Exterior formed concrete surfaces:
  - .1 Finish exposed surfaces and surfaces to receive insulation and/or roofing material to Smooth-Formed Finish conforming to CAN/CSA-A23.1-04, Clause 7.7.3.6
  - .2 Finish other non-exposed surfaces to Rough-Formed Finish conforming to CAN/CSA-A23.1-04, Clause 7.7.3.5

### 3.15 Finishing Walks, Curbs, Ramps, Steps

- .1 Finish edges of walks, curbs, ramps, steps to smooth radius
- .2 On walks, tool control joints across at 1.5 m o.c.
- .3 On platforms and ramps, tool control joints at 1.5 m o.c. both ways
- .4 Broom finish surface of platforms, steps, walks, curbs and ramps
- .5 Apply curing and sealing compound to manufacturer's directions

### 3.16 Grouting

- .1 Install non-shrink grout under columns, beams and equipment bases as shown on Drawings and in accordance with the manufacturer's recommendations.

## 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.

### 3.17 Defective Concrete

- .1 Concrete not meeting the requirements of this Section and Drawings shall be considered defective concrete.
- .2 Concrete not conforming to the lines, detail and grade specified herein or as shown on the Drawings shall be modified or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator. Finished lines, dimensions and surfaces shall be correct and true within tolerances specified herein and in the General Specifications.
- .3 Concrete not properly placed resulting in excessive honeycombing, and all honeycombing and other defects in critical areas of stress shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.
- .4 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When five or more tests of the same class of concrete are available, the average of any five consecutive tests shall be equal to, or greater than the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. If any of the criteria of the above clause are not met, the Contract Administrator shall have the right to require one or more of the following:
  - .1 Changes in mix proportions for the remainder of the Work.
  - .2 Cores drilled and tested from the areas in question as directed by the Contract Administrator and in accordance with CAN/CSA-A23.2-04. The test results shall be indicative of the strength of the in-place concrete.
  - .3 Load testing of the structural elements. The changes in the mix proportions, cores drilled and tested and load testing shall be at the Contractor's expense.
- .5 Concrete failing to meet the strength requirements of this Technical Requirement shall be strengthened or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.

### 3.18 Clean-Up

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

**END OF SECTION**

## **GROUT**

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### **1. GENERAL**

#### **1.1 Work Included**

- .1 Formwork for grout
- .2 Prepare surfaces to receive grout
- .3 Grout scale load cells

#### **1.2 Job Conditions**

- .1 Maintain surfaces and ambient air temperature of minimum 10°C for a minimum period of 24 hours prior to, during, and 72 hours after application.
- .2 If grouting outside, provide and maintain temporary weatherproof enclosures during inclement weather during preparation, grouting, and curing.

### **2. PRODUCTS**

#### **2.1 Grout**

- .1 Non-ferrous Grout: pre-mixed, non-shrink, Master Flow 928, SonogROUT 14K Hyflow, Sika Grout 212 HP.

#### **2.2 Formwork Materials**

- .1 Plywood: Douglas Fir plywood, G1S, undamaged sheets with true edges
- .2 Lumber: sound, sizes as required
- .3 Nails, Spikes, Staples: all galvanized steel

### **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.

## **GROUT**

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### **3.2 Surface Preparation**

- .1 Remove all defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by bush-hammering, chipping, or other similar means, until a sound, clean concrete surface is achieved.
- .2 Lightly roughen surface to ensure proper bond with grout.
- .3 Remove paint primers, where possible, from all ferrous metal surfaces in contact with grout.
- .4 Follow manufacturer's directions respecting saturation of surfaces with water prior to grouting.

### **3.3 Formwork**

- .1 Construct formwork accurately, ensuring grout conforms to lines, levels, and dimensions indicated on Drawings.
- .2 Arrange and assemble formwork to permit easy dismantling and stripping, ensuring grout is not damaged during its removal.
- .3 Provide sufficient clearance for proper placement between formwork and area being grouted.
- .4 Cover form surfaces with an acceptable release coating to prevent bond to grout.

### **3.4 Review**

- .1 Notify the Contract Administrator prior to placing grout, to permit review of formwork and placing of grout.

### **3.5 Mixing**

- .1 Mix grout materials with clean, potable water in accordance with manufacturer's directions. Use minimum amount required for workable mixture.
- .2 Mix grout as close to Work as possible. Transport quickly and in a manner that does not permit segregation of materials.
- .3 Do not permit any water to be added after grout has been mixed. Retempering grout is not acceptable.

### **3.6 Installation**

- .1 If necessary, heat surfaces to minimum temperature recommended by manufacturer.
- .2 Place grout quickly and continuously by most practical means permissible, as recommend by manufacturer.

## **GROUT**

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- .3 Thoroughly compact grout, free from voids and air pockets.
- .4 Cut and trowel edges of grout to true lines.

### **3.7 Curing**

- .1 Moist cure grout to manufacturer's directions.

### **3.8 Form Removal, Repairs**

- .1 Remove forms after time as directed by manufacturer's directions.
- .2 Repair any visible defects in grouting, patch with matching grout.

**END OF SECTION**