

CONCRETE FORMWORK

1. GENERAL

1.1 Work Included

- .1 Forms for all concrete and supporting falsework including 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 NBC, CSA Standards CAN/CSA-A23.1-00, CSA S269.1, CAN/CSA S269-3, ACI 347R, and applicable construction safety regulations.
- .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-A23.1-00, 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, reshoring, etc.
- .3 For void form indicate thickness, crushing load, method for moisture protection, and method to ensure collapse after concrete achieves design strength.

CONCRETE FORMWORK

- .4 Shop Drawings and design briefs are to bear the seal of a Professional Engineer, registered in the Province of Manitoba.
- .5 Formwork, falsework, and reshoring are to be reviewed by the same Professional Engineer prior to each concrete pour.
- .6 Professional Engineer to report, in writing, that reviewed formwork, falsework, and reshoring are in accordance with the design prior to each concrete pour.

1.5 Measurement and Payment

- .1 No measurement will be made for the Work in this Section.
- .2 Include costs in the unit prices bid for the various items of work as listed in the Schedule of Prices.

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: moisture-resistant treated paper faces; bio-degradable, structurally sufficient to support weight of wet concrete mix and construction loads until initial set under structurally supported slabs, walls, and beams where indicated on the Drawings. Protection shall be one (1) layer of 12.7 mm thick spruce plywood sheeting.

CONCRETE FORMWORK

2.5 Accessories

- .1 Form ties: removable snap-off metal type, galvanized, fixed length, minimum working strength of 13 kN when assembled. For non-water retaining structures use minimum 25 mm deep 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.
- .3 Corner or chamfer fillets: mill finished pine, widths as indicated on the Drawings, maximum possible lengths, mitre ends.
- .4 Reglets: mill finished pine, shaped to required cross-section, maximum possible lengths, mitre ends.
- .5 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 as necessary.
- .5 Arrange forms to allow removal without removal of principal shores, where these are required to remain in place.
- .6 Obtain Contract Administrator's acceptance before framing openings in concrete slabs, walls, and beams not indicated on Drawings.

CONCRETE FORMWORK

- .7 Provide falsework to ensure stability of formwork. Brace 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 internal and external corners and edges, vertical and horizontal, of exposed concrete unless shown otherwise.
- .10 Form chases, slots, openings, drips, and recesses as detailed on 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 Locate construction joints for beams and suspended slabs where shown or noted on the Drawings.
- .14 Provide reveals or reglets on construction joints as shown on the Drawings.

3.3 Void Form

- .1 Void forms shall be placed on prepared surfaces of levelling sand so that the top of the void forms present flat forming surfaces.
- .2 Protect void form from wetting from fresh concrete and moisture from ground as per manufacturer's instructions.
- .3 Ensure collapse of void form after concrete has achieved design strength.

3.4 Tolerance

- .1 Construct formwork to produce concrete with dimensions, lines, and levels within tolerances specified in ACI 347R, Guide to Formwork for Concrete, or as shown on the Drawings; the most stringent requirements shall apply.

3.5 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 – Concrete Accessories.

CONCRETE FORMWORK

- .5 Provide temporary ports or openings in formwork where required to facilitate cleaning and construction 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.

3.6 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. Submit written report from Professional Engineer responsible for this work as specified in Clause 1.4 Shop Drawings.
- .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 forms are clean and free from debris.
- .3 Allow Contract Administrator to review each section of formwork prior to re-use. Formwork may be re-used if acceptable to the Contract Administrator.

3.7 Cleaning

- .1 Clean forms to remove foreign matter as erection proceeds. 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.

3.8 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.

3.9 Form Removal

- .1 Notify 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 and design loads that are liable to be imposed. Verify strength of concrete by compression tests to satisfaction of Contract Administrator.
- .3 Forms shall remain in place a minimum of two (2) calendar days and the concrete shall have attained 75% of design strength verified by field cured test cylinders.

CONCRETE FORMWORK

- .4 Remove falsework progressively, in accordance with regulatory requirements and ensure that no shock loads or imbalanced loads are imposed on structure.
- .5 Loosen forms carefully without damaging concrete surfaces. Do not apply tools to exposed concrete surfaces.
- .6 If forms are left loosely in place for protection until curing requirements are complete, ensure all concrete surfaces are kept continuously wet with use of soaker hoses. Otherwise remove forms and start wet cure immediately by use of soaker hoses or accepted curing compound.

3.10 Reshoring

- .1 If reshoring is required, prepare and submit a schedule to Contract Administrator for review.
- .2 Reshore structural members where required due to design requirements or construction conditions under the direction of the Professional Engineer responsible for this work.
- .3 Install reshoring as required to permit progressive construction.

END OF SECTION

CONCRETE REINFORCEMENT

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.

1.2 Quality Assurance

- .1 Perform concrete reinforcing Work in accordance with CSA Standard 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 Shop Drawings in accordance with Section 01300 – Submittals.
- .2 Clearly indicate bar sizes, spacings, locations, and quantities of reinforcing steel and wire fabric, bending and cutting schedules, and supporting and spacing devices.
- .3 Drawings and details to 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.

1.6 Measurement and Payment

- .1 No measurement will be made for the Work in this Section.
- .2 Include costs in the unit prices bid for the various items of work as listed in the Schedule of Prices.

CONCRETE REINFORCEMENT

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.
- .2 Welded steel wire fabric: plain type, conforming to ASTM A185; flat sheets; plain finish.

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 for exposed surfaces: to be non-corrosive PVC chairs or concrete chairs purpose made. Steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.
- .4 Bar chairs for non-exposed surfaces: broken concrete blocks, stones, and wood supports are not acceptable.

3. EXECUTION

3.1 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: plus 0, minus 25 mm.
 - .2 Stirrups, ties, and spirals: plus 0, minus 10 mm.
 - .3 Other bends: plus 0, minus 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 rebent or straightened unless so indicated on the Drawings.
- .6 Heating of reinforcing steel will not be permitted.

CONCRETE REINFORCEMENT

3.2 Installation

- .1 Place reinforcing steel in accordance with reviewed Shop Drawings and CAN/CSA-A23.1-00. 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-A23.1-00, but not less than shown on Drawing Concrete Notes.
- .4 Maintain alignment as follows:
 - .1 Slabs: ± 5 mm.
 - .2 Other structural members: ± 10 mm.
 - .3 Rebar bends and ends: ± 50 mm.
- .5 Do not disturb or damage polyethylene film or void form while placing reinforcing steel.
- .6 Install purpose made highly visible protective safety caps on all exposed projecting bar ends to the satisfaction of the Contract Administrator.

3.3 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 prior to next adjacent concrete pour.
- .3 Remove concrete splatter on bars before concrete has hardened.

END OF SECTION

CONCRETE ACCESSORIES

1. GENERAL

1.1 Work Included

- .1 Joint Sealants.
- .2 Expansive Waterstop.
- .3 Joint Filler.
- .4 Non-ferrous Grout.
- .5 Latex Patching Agent.
- .6 Epoxy Bonding Agent.
- .7 Curing Compound.
- .8 Moisture Retention Film.
- .9 Fasteners.

1.2 Measurement and Payment

- .1 No measurement will be made for the Work in this Section.
- .2 Include costs in the unit prices bid for the various items of work as listed in the Schedule of Prices.

2. PRODUCTS

2.1 General

- .1 All materials shall be subject to the acceptance of the Contract Administrator.

2.2 Materials

- .1 Joint Sealants:
 - .1 Sealants for all joints shall be non-sag two-part polysulphide, acceptable product Thiokol 2235M by PolySpec.
 - .2 Use compatible primer as per sealant Manufacturer's requirements.
- .2 Expansive waterstop: acceptable products are SikaSwell S Sealant by Sika and CS-231 Controlled Expansion Waterstop by ConSeal Concrete Sealants.
- .3 Joint filler: rigid closed cell foam, CPD PVC Closed Cell Joint Filler.

CONCRETE ACCESSORIES

- .4 Non-ferrous grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, Grace In-Pakt Grout, minimum 35 MPa compressive strength.
- .5 Latex patching agent: Acril Stix, Daraweld-C Latex Bonding Agent.
- .6 Epoxy bonding agent: Master Builders Concrecive 1001 LPL, Dural Duralbond, Sikadur 32 HI-bond.
- .7 Curing compound: conforming to ASTM C309.
- .8 Moisture retention film: Master Builders Confilm.
- .9 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.

2.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300 – Submittals.
- .2 Submit product information for review for materials to be incorporated into the Work.

3. EXECUTION

3.1 Installation

- .1 Coordinate Work of this Section with other construction.
- .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.
- .5 Joint sealant shall be applied per Manufacturer's instructions. If joint surfaces are damp, dry the joint surfaces and apply primer as recommended by Manufacturer.
- .6 Expansive waterstop: apply to clean surfaces in uniform continuous beads per manufacturer's instructions.
- .7 Latex patching agent is to be used for patching formed concrete surfaces where required.
- .8 Epoxy bonding agent is to be used to bond new concrete to existing concrete surfaces.

CONCRETE ACCESSORIES

- .9 Moisture retention film is to be used during hot windy weather conditions to prevent moisture loss immediately after concrete placement; apply per Manufacturer's instructions.

END OF SECTION

CAST-IN-PLACE CONCRETE

1. GENERAL

1.1 Work Included

- .1 All 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 concrete slab surfaces.
- .6 Curing of concrete.

1.2 Quality Assurance

- .1 Cast-in-place concrete shall conform to the 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-trades, and Contract Administrator.
- .4 A Concrete Pour Release Form shall be completed prior to each concrete pour. The Contractor shall be responsible for completing the forms. Each form shall be signed by the Contractor and Contract Administrator prior to each pour.

1.3 Qualification

- .1 Concrete flatwork finishing is to be done by an established firm having at least five (5) years of proven, satisfactory experience in this trade and employing skilled personnel.
- .2 Submit proof of qualifications in writing to the Contract Administrator.

1.4 Inspection & Testing

- .1 Notify the Contract Administrator at least forty eight (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.

CAST-IN-PLACE CONCRETE

- .4 Provide unencumbered access to all portions of Work and cooperate with appointed firm.
- .5 Submit proposed mix design statements for each class of concrete to the Contract Administrator for review ten (10) Business Days prior to commencement of the Work. If blended cement is proposed for sulphate resistant concrete, testing data supporting conformance to CSA-A3000 shall be submitted with the mix design statement
- .6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.
- .7 Notify the Contract Administrator at least twenty four (24) hours in advance of any concrete placement.
- .8 At least three (3) concrete test cylinders will be taken for every seventy five (75) or less m³ of each class of concrete placed.
- .9 At least three (3) 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 (up to every truck) to verify quality of concrete at the discretion of the Contract Administrator.
- .12 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.
- .13 The Contractor shall pay costs for required retesting due to defective materials or workmanship.
- .14 If accepted by the Contract Administrator, the Contractor may arrange and pay for additional tests for use as evidence to expedite construction.
- .15 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When three (3) or more tests of the same class of concrete are available, the average of any three (3) consecutive tests shall be equal to, or greater than the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. If any of the criteria of the above clause are not met, the Contract Administrator shall have the right to require one or more of the following:
 - .1 Changes in mix proportions for the remainder of the Work.
 - .2 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.

CAST-IN-PLACE CONCRETE

- .4 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 Specification shall be strengthened or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.

1.5 Measurement and Payment

- .1 No measurement will be made for the Work in this Section.
- .2 Include costs in the unit prices bid for the various items of work as listed in the Schedule of Prices.

2. PRODUCTS

2.1 General

- .1 All materials in concrete mixes shall be compatible.

2.2 Concrete Materials

- .1 Cement: sulphate resistant Normal Type 50 Portland Cement or HSb conforming to CSA-A3000. When HSb is proposed, submit supporting testing data showing conformance to CSA-A3000 satisfactory to the Contract Administrator.
- .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 (2) 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, 40-5 mm, 20-5 mm, and 10 to 2.5 mm. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to Normal-Density Coarse Aggregate, CAN/CSA-A23.1-00, Table 5 and Table 6. Group II may be used for special requirements such as gap grading, pumping, or for blending two (2) or more sizes to produce Group I gradings.
- .4 Ensure that no aggregates are used that may undergo volume change due to alkali reactivity, moisture retention, or other causes. Confirm suitability of aggregate with a petrographic analysis if deemed necessary by the Contract Administrator.
- .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.

CAST-IN-PLACE CONCRETE

- .7 Supplementary cementing materials: conforming to CSA-A23.5.

2.3 Admixtures

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

2.4 Accessories

- .1 For accessories refer to Section 03250 – Concrete Accessories.

2.5 Concrete Mixes

- .1 Pay all costs for mix design. Submit mix designs to the Contract Administrator for review a minimum of ten (10) Business Days prior to concrete pour.
- .2 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-00 and as indicated on the Drawings. The Drawing requirements shall govern where there is a difference between the Drawings and CAN/CSA-A23.1-00, Tables 6 to 10 requirements.
- .3 Maximum allowable substitution of cement with supplementary cementing materials shall be 20% by weight except that blended cements may contain the amount of supplementary cementing materials as required for the intended purpose such as sulphate resistance. Blended cements shall be used as blended by the Manufacturer without additional substitution of cement with supplementary cementing materials unless the resulting blend is supported with testing data showing conformance to CSA-A3000 satisfactory to the Contract Administrator.
- .4 Concrete: exposure class S1, minimum design 56-day compressive strength 35 MPa, nominal aggregate Group 20 - 5 mm, maximum water:cementitious material 0.40, total air 4% to 7%. Concrete for walls and beams shall be superplasticized.
- .5 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.
- .6 Use set-retarding admixtures during hot weather only when accepted by the Contract Administrator.

CAST-IN-PLACE CONCRETE

- .7 All materials and 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.
- .8 All admixtures are subject to acceptance by the Contract Administrator. List all proposed admixtures in mix design submission. Do not change or add admixtures to accepted design mixes without the Contract Administrator's review and acceptance.
- .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-cement ratio.
- .10 Patching Mortar:
 - .1 The patching mortar shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one (1) part cementitious material to two and a half (2.5) parts sand by damp loose volume.
 - .2 White Portland Cement shall be substituted for a part of the grey Portland Cement on exposed concrete in order to produce a colour matching the colour of the surrounding concrete, as determined by a trial patch.
 - .3 The quantity of mixing water shall be no more than necessary for handling or placing. Mixing water shall include one (1) part latex bonding agent to three (3) parts water. Maximum water:cementitious material ratio shall be 0.40.
- .11 Self-compacting concrete mixes will not be permitted for use on this project.

3. EXECUTION

3.1 Placing Concrete

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

CAST-IN-PLACE CONCRETE

- .5 All equipment for transporting the concrete shall be cleaned of hardened concrete and foreign materials before placing concrete.
- .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 all reinforcing steel and embedded parts are in the correct position and secured against movement during the placing operation. All forms shall be thoroughly cleaned and material removed.
- .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. Concrete 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 iron chutes. Concrete shall not be raised at a rate greater than that for which proper vibration may be affected.
- .12 In locations where new concrete is dowelled to existing concrete, drill holes in existing concrete, insert steel dowels, and pack solidly with non-shrink grout.
- .13 A minimum of three (3) days shall elapse between adjacent pours separated by construction joints or expansion joints.
- .14 Do not place concrete if carbon dioxide producing equipment has been in operation in the building or in the enclosure during the twelve (12) hours preceding the pour. This equipment shall not be used during placing or for twenty four (24) hours after placing. During placing and curing concrete, surfaces shall be protected by formwork or an impermeable membrane from direct exposure to carbon dioxide, combustion gases, or drying from heaters.
- .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 pour, quantity, air temperature, and test samples taken.

CAST-IN-PLACE CONCRETE

- .18 Prior to the erection of the formwork for walls, the construction joint shall be sand blasted and cleaned as per Clause 3.14 of this specification section. A layer of grout slurry approximately 12 mm to 25 mm thick shall be placed immediately prior to the placement of concrete.

3.2 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 job 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 (7) calendar days. The concrete shall be kept above freezing temperature for at least a period of seven (7) calendar 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, complete with heaters, fuel, maintenance, and attendants 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 Before depositing any of the concrete, the Contractor shall show that enough heating equipment is available to keep the air temperature surrounding the forms within the specified range. This shall be accomplished by bringing the temperature inside of the housing to the specified 10°C at least twelve (12) hours prior to the start of the concrete placing.

CAST-IN-PLACE CONCRETE

- .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.

3.3 Hot Weather Concreting

- .1 General:
 - .1 The requirements of this Clause 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 Forms 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

.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 under “Sever Drying Conditions” below, 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 (metres)	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/m²/hr, windbreaks shall be erected around the sides of the structural element.

.2 Severe Drying Conditions:

- .1 When surface moisture evaporation exceeds 1.0 kg/m²/hr, additional measures 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.
 - .6 Application of moisture retention film.

CAST-IN-PLACE CONCRETE

.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.

3.4 Concrete Protection for Reinforcement

- .1 Ensure reinforcement is placed to provide minimum concrete cover in accordance with Section 03200 – Concrete Reinforcement.

3.5 Construction Tolerance

- .1 The Work shall be carefully and accurately set out; true to the positioning, levels, slopes, and dimensions shown on the Drawings and conforming to Sections 03100 – Concrete Formwork and 03200 – Concrete Reinforcement.
 - .1 Sizes of member or thickness of slabs:
 - .1 300 mm or less: +/- 6 mm
 - .2 301 mm to 1000 mm: +/- 12 mm
 - .3 1001 mm or greater: +/- 20 mm
 - .2 Cover of concrete over reinforcement: ± 3 mm.
 - .3 Variations from plumb: 6 mm in 3.0 m, 14 mm maximum.
 - .4 Variations from flat: 3 mm in 3.0 m, 6 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.

3.6 Finishing Slab Surfaces

- .1 Finish all slab surfaces conforming to CAN/CSA-A23.1-00, Clause 22 and as specified below.
- .2 Bull Floating:
 - .1 Immediately after screeding, bull float floor surfaces to remove ridges and fill voids.
 - .2 Complete bull floating before any excess moisture or bleed water is visible on surface.

CAST-IN-PLACE CONCRETE

- .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 corners, restricted areas, and around cast-in items.
- .4 Trowelling:
 - .1 Trowel floor surfaces with mechanical trowelling machines fitted with steel 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 corners, restricted areas, and around cast-in items.
 - .6 Cure concrete as specified.
 - .7 Protect all floors from damage during construction.

3.7 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 (7) calendar 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 and continuously wet with soaker hoses.
 - .2 A liquid membrane forming curing sealer, applied at the rate recommended by the Manufacturer. Curing sealer shall not be used on a surface where bond is required for the finishes.

CAST-IN-PLACE CONCRETE

- .3 Surfaces of concrete, which are protected by formwork that is left in place for seven (7) calendar days, shall not require any additional curing (except as specified for hot weather). If the formwork is removed in less than seven (7) calendar days, the concrete shall receive moist curing as above.
- .3 No concreting will be allowed until all materials required for the curing phase are on Site and ready for use.
- .4 At the end of the curing and protection period, the temperature of the concrete shall be reduced gradually at a rate not exceeding 10°C per day until the outside air temperature has been reached.
- .5 Concrete that is allowed to freeze or attain insufficient curing conditions shall be subject to all necessary investigations and testing as deemed necessary by the Contract Administrator and all such concrete shall be removed and the portion reconstructed as directed by the Contract Administrator, at Contractor's cost.
- .6 The supply (both quantity and time of supply) of water for curing concrete shall be subject to control of the City and prior arrangements shall be made by the Contractor with the City for its supply. The Contractor shall be responsible for, at his own cost, to supply, install, maintain, and move extensions to water services as required for conveying water to the work Site. Water required for curing concrete will be supplied by the City, from the DBPS.

3.8 Formed Concrete

- .1 Allow the Contract Administrator to review concrete surfaces immediately upon removal of the forms.
- .2 Modify or replace concrete not conforming to qualities, lines, details, and elevations specified herein or indicated on the Drawings to the acceptance of the Contract Administrator.

3.9 Finishing Formed Surfaces

- .1 Finish surfaces exposed to view to Smooth-Form Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.6.
- .2 Finish non-exposed surfaces to Rough-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.5.

3.10 Equipment Pads, Pipe Supports, and Cast in Metal Frames

- .1 Provide concrete pads and supports for equipment 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.

CAST-IN-PLACE CONCRETE

- .3 Steel trowel surface smooth. Chamfer exposed horizontal and vertical edges.
- .4 Clean excess concrete from metal frames, inserts, weld plates, etc. Clean and tool concrete around the above noted items.

3.11 Grouting

- .1 Grout all miscellaneous anchor bolts with non-ferrous or epoxy grout as specified using templates for accurate positioning.
- .2 Grout under base plates and other items to provide continuous support over the entire contact area as required and shown on the Drawings.

3.12 Defective Concrete

- .1 Concrete not meeting the requirements of the Specifications and Drawings will be considered defective concrete.
- .2 Concrete not conforming to the lines, details, and grades 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 Section 03100 – Concrete Formwork.
- .3 Concrete not properly placed resulting in honeycombing and other defects shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.

3.13 Patching

- .1 Allow Contract Administrator to review concrete surfaces immediately upon removal of all formwork.
- .2 Remove all exposed metal form ties, nails and wires, break off fins, and remove all loose concrete.
- .3 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. 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 wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar.
- .4 Cure all patches thoroughly in accordance to Manufacturer's instructions.

3.14 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.

CAST-IN-PLACE CONCRETE

- .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 or other mechanical means.
- .4 For horizontal construction joints, the concrete shall be thoroughly compacted by hand trowel in and around the reinforcing bars.

3.15 Clean-Up

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

END OF SECTION