# General

## References

### Provide concrete formwork in accordance with the following standards (latest revision) except where specified otherwise.

### American Concrete Institute (ACI).

#### ACI 347R Guide to Formwork for Concrete.

### Canadian Standards Association (CSA).

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CAN/CSA-S16 Design of Steel Structures.

#### CSA-S269.1 Falsework for Construction Purposes.

#### CAN/CSA-S269.3 Concrete Formwork.

#### CSA-O86 Engineering Design in Wood.

## Submittals

### Provide the following submittals.

### For “Record Purposes Only,” copies of the formwork design drawings including allowable concrete pour rate as specified in clause 1.3 at least 15 days prior to erection.

### Written documentation from the formwork design engineer certifying that the formwork construction complies with the design at least 1 day prior to concrete placement.

## Quality Control

### Design of Formwork and Shoring by the Contractor

#### Provide the design for all formwork and shoring. Design formwork to safely support all vertical and lateral loads, and so all concrete members will be of correct dimension, shape, alignment, elevation, position, and have a surface finish within specified tolerances. In general, design formwork in accordance with the applicable requirements of ACI 347R, CSA-O86, CAN/CSA-S16, CSA-S269.1, and CAN/CSA-S269.3. [Account for tensioning requirements of the form liner in the formwork design.]

#### Provide formwork and shoring that has been designed and stamped by a Professional Engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

#### Re-design and replace any type of form or method of erection that does not consistently produce concrete work that meets the specified tolerances or finish requirements.

### Regulatory Requirements

#### Comply with the requirements of all applicable codes and regulations respecting safety in the design and construction of formwork and shoring.

## Delivery, Storage, and Handling

### Store formwork with the forming surfaces off the ground, and keep the forming surfaces clean.

### Keep form liner away from direct exposure to sunlight..

# Products

## Materials

### Provide materials in accordance with the following.

### Forms: Materials, consisting of lumber, steel, or other materials specifically designed for use as formwork, that are capable of consistently providing the specified lines, shapes, and finishes. Do not use modular forms such as basement wall forming systems.

### Form Ties: Internal form ties consisting of metal rods or bars of a type authorized by the Minister. Use ties that remain in the finished concrete and are designed to break off at least 25 mm inside the final surface after the forms are removed. Provide ties with removable cones.

### Hangers: Break-off type hangers with removable cones or removable thread type hangers for deck forms.

### Form Release Agent: Non-volatile type that does not cause chemical deterioration or discoloration of the concrete surface. Obtain the Minister’s authorization for the proposed form release agent prior to its use.

### Form liner for walls: Controlled permeability form liner made from polypropylene fibres as manufactured by [ ].

# Execution

## Preparation

### Thoroughly clean forms of all dirt, mortar, and foreign matter before use.

### Remove and replace formwork that is damaged, warped, distorted, or otherwise flawed as directed by the Minister.

### Apply form release agent [, except where form liner is provided,] before placing reinforcing steel. Do not allow form release agent to coat reinforcing steel, or concrete surfaces at construction joints.

## Installation

### Provide forms wherever required to confine and shape concrete to the lines specified in the Contract Documents.

### Provide forms that are sufficiently tight to prevent loss of mortar from the concrete.

### Securely tie and brace the forms to maintain their shape and position, and to avoid warping and bulging. Minimize the number of form joints.

### Fill joints between panels and depressions with sealant, and smooth off projections.

### Provide 25 mm chamfers at all permanently exposed edges.

### Arrange formwork for ease of dismantling and stripping, and so that removal of the forms does not damage the concrete. For blocking and supports which are to be left permanently in the concrete, fabricate the formwork blocking and supports from steel.

### Do not use reinforcing steel, embedded parts, [or rock anchors] to support the forms.

### Provide access panels at the bottom of wall forms to facilitate thorough inspection and removal of deleterious materials before concrete placement.

### Properly identify, position, and secure blockouts, inserts, sleeves, anchors, conduits, and other embedded items.

### Fabricate and erect falsework in accordance with CSA-S269.1.

## [Form Liner Installation]

### Install form liner in accordance with the manufacturer’s written instructions.

### Provide form liner where [F2 and F3] formed concrete finish is required.

### Reuse form liner only if it is manufactured for multiple use, it is properly maintained, and its performance is comparable to that of a new liner as determined by the Minister. Do not use the same form liner more than 3 times.

### Do not apply release agent to any part of the formwork that is in contact with the form liner. Thoroughly clean the face of the form liner of all dirt, dust, and release agent residue prior to attaching the liner.

### Tension the form liner in both directions. Expose the form liner to sunlight prior to tensioning. Use special tools and techniques to achieve the required elongations in accordance with the manufacturer’s written instructions.

### Install form liner square on the formwork. Provide a minimum overhang of 50 mm all around the formwork, and a minimum of 150 mm at the ends where principal tensioning is performed.

## Tolerances

### Design, construct, and maintain formwork so that the completed concrete work is within the specified structural tolerances for lines, levels, and dimensions as follows, or within the surface finish tolerances specified in Section [ ] – Cast-in-Place Concrete, whichever is more stringent.

### Tolerances are not cumulative and the most stringent requirements apply.

### Structural tolerances [, except within gate bays]:

#### Variation from plumb, batter, or level: [+/-12 mm].

#### Rate of variation from plumb or batter: [1H:500V] for permanently exposed surfaces, and [1H:250V] for permanently concealed surfaces.

#### Rate of variation from level or slopes: [1H:500V] for permanently exposed surfaces, and [1H:250V] for permanently concealed surfaces.

#### Variation in cross sectional dimensions of slabs, footings, walls, piers, and decks: [–6 mm] and [+12 mm].

#### Variation of protective concrete cover for reinforcing steel: [+/-12 mm].

### Structural tolerances within gate bays:

#### Variation from plumb, batter, or level within [1000 mm] of [gate frames, gate sealing plates: [+/-4 mm].]

#### Variation in horizontal distance between vertical walls within the gate bay: [+/-12 mm].

#### Variation in weir crest level: [+/-6 mm]. Rate of variation from weir crest level: [1H:1000V].

#### Variation in location of blockouts and openings: [+/-6 mm].

### Tolerances for dimensions shown on the Drawings: Actual dimensions measured from a horizontal and vertical reference grid system to be within the tolerances specified in CAN/CSA-A23.1 [Clause 6.4.6]

## Concrete Placement

### Provide measures and means authorized by the Minister for checking alignment and elevations of forms, and to detect movements of the formwork and shoring during concrete placement.

### Immediately prior to concrete placement, inspect the forms and verify that they are properly located, sufficiently rigid and tight, and clean and free of foreign material.

### Provide experienced personnel to continuously inspect formwork and shoring for early detection of possible displacements, abnormal deflections, or other signs of distress during concrete placement. Provide additional bracing, wedges, shoring, and other materials as necessary to facilitate immediate adjustments as required.

### Keep vibrators at least 50 mm away from the face of the formwork. Avoid excessive vibration of concrete.

### Repair any concrete defects caused by faulty or inaccurate formwork.

## Formwork Removal

### Maintain formwork and shoring in place until the concrete has attained sufficient strength to support its own weight, construction loads, and other imposed loads.

### Obtain authorization from the Minister prior to removing forms or shoring. Authorization by the Minister to remove forms does not in any way relieve the Contractor of its obligations to delay the removal of forms and shoring until the concrete has attained sufficient strength to support its own weight, construction loads, and other imposed loads.

### Without limiting the Contractor’s responsibilities in clause 3.6.1, maintain forms or shoring in place for at least the following times after completion of concrete placement and obtain the Minister’s confirmation that these times have been reached.

#### Footings and slabs on grade 24 hours

#### Vertical forms of walls 48 hours

#### Soffits of beams and slabs 14 days

### Remove formwork with care to avoid damage to the concrete, and to produce sharp clean joints and edges.

### After removal, carefully clean and repair forms to be reused so the specified quality of the formed surface is achieved. Thoroughly remove film or splatter of hardened concrete.

## Clean-Up

### Clean-up and properly dispose of all formwork, temporary supports, tie rods, and construction debris.

**END OF SECTION**

# General

## Detail Drawings

### The following detail drawings are appended hereto and form part of this section.

### **Number Title**

### [ ] Typical PVC Waterstop Fittings

### [ ] Typical PVC Waterstop Splice Details

## References

### Provide Polyvinyl Chloride (PVC) waterstop in accordance with the following standards (latest revision) except where specified otherwise.

### American Society for Testing and Materials (ASTM)

#### ASTM D471 Standard Test Method for Rubber Property–Effect of Liquids.

#### ASTM D624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

#### ASTM D638 Standard Test Method for Tensile Properties of Plastics.

#### ASTM D746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

### Canadian General Standards Board (CGSB).

#### CGSB 41–GP–35M Polyvinyl Chloride Waterstop.

## Submittals

### Provide the following submittals.

### The manufacturer’s affidavit or test certificate certifying that the waterstop being supplied meets the specified requirements at least 15 days prior to delivery to the Site.

### Manufacturer’s written instructions for splicing and supporting waterstop at least 15 days prior to performing the work.

## Quality Control

### Arrange and have the manufacturer’s representative visit the Site at the beginning of the waterstop installation to demonstrate the proper procedure for field splicing, and the methods for installing, securing, and embedding the waterstop in concrete. Provide the Minister at least 24 hours advance notification of the time and place of such demonstrations.

## Delivery, Storage, and Handling

### Inspect each shipment of material and timely replace any damaged materials.

### Provide the waterstop in rolls containing a single length of not less than 15 m and having an internal diameter of not less than 300 mm.

### Store the waterstop indoors and away from exposure to the direct rays of the sun or temperatures colder than 5°C. Protect the waterstop from contact with oil, grease, and dirt.

# Products

## Materials

### Provide materials in accordance with the following.

### Waterstop:

#### Manufacture waterstop from plastic compound of which the basic resin is polyvinyl chloride. Incorporate additional resins, plasticizers, inhibitors, or other ingredients necessary to achieve the specified requirements. Do not use any reclaimed or reprocessed material in the compound.

#### Fabricate waterstop using [arctic] grade material with the following physical properties:

##### Tensile strength not less than [15 MPa], when tested in accordance with ASTM D638 Type IV.

##### Ultimate elongation not less than [370%], when tested in accordance with ASTM D638 Type IV.

##### Modulus of elasticity not less than [12 MPa], when tested in accordance with ASTM D638, Type IV.

##### Tear resistance not less than [58 kN/m], when tested in accordance with ASTM D624, Die “B.”

##### Low temperature brittleness of [–50°C], when tested in accordance with ASTM D746.

##### Change in mass due to alkali effects not greater than [6.5%], when tested in accordance with ASTM D471 and CGSB 41–GP–35M.

##### Ultimate elongation due to alkali effects not less than [300%], when tested in accordance with ASTM D471 and CGSB 41–GP–35M.

#### Extruded PVC multi-ribbed waterstop sections that are dense, homogeneous, and free from welds, splices, or other imperfections.

#### Symmetrical in shape and having the dimensions specified in the Contract Documents. Tolerances are +/-1.6 mm for width and +/-0.8 mm for thickness.

#### Fittings as specified in the Contract Documents.

# Execution

## Installation

### Perform field splices, as specified in the Contract Documents, by heat sealing using a thermostatically controlled heating iron in accordance with the manufacturer’s written instructions.

### For the field splicing procedure:

#### Ends are to be square and clean.

#### Areas of splices are to be undamaged by heat.

#### Splices are to have a tensile strength of not less than 80% of the tensile strength of the unspliced material.

#### Ribs and centre bulbs are to match exactly and be continuous.

### Avoid damaging the ribs. Remove and discard any damaged, torn, or suspect sections.

### Position and support the waterstop to provide approximately equal width of material embedded in the concrete on each side of the joint.

### Clean the waterstop of all contaminants that could impair bonding with concrete.

### Support the waterstop [as specified in the Contract Documents] [in accordance with the manufacturer’s written instructions] to prevent displacement during placement of concrete, and to maintain the waterstop perpendicular to the concrete joint over its full length.

### Work and compact the concrete adjacent to the waterstop to provide full contact with the waterstop, and to eliminate the formation of air pockets.

**END OF SECTION**

# General

## References

### Provide concrete accessories in accordance with the following standards (latest revision) except where specified otherwise.

### Canadian Standards Association (CSA).

#### CSA-O80 Series Wood Preservation.

#### CSA-O121 Douglas Fir Plywood.

### Canadian General Standards Board (CGSB)

#### CAN/CGSB-19.13 Sealing Compound, One-Component, Elastomeric, Chemical Curing.

#### CAN/CGSB-37.2 Emulsified Asphalt, Mineral-Colloid Type, Unfilled, for Damproofing and Waterproofing and for Roof Coatings.

### American Society of Testing and Materials (ASTM)

#### ASTM C920 Standard Specification for Elastomeric Joint Sealants.

#### ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension.

#### ASTM D746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

#### ASTM D1056 Standard Specification for Flexible Cellular Materials- Sponge or Expanded Rubber.

#### ASTM D1499 Standard Practice Filtered Open-Flame Carbon-Arc Exposures of Plastics.

#### ASTM D1667 Standard Specification for Flexible Cellur Materials- Poly –(Vinyl Chloride) Foam (Closed-Cell).

## Submittals

### Provide the following submittals.

### Product data, including samples when requested by the Minister, at least 15 days prior to delivering any materials to the Site.

### Manufacturer’s written instructions for handling, storing, and installing materials at least 15 days prior to performing the work.

## Delivery, Storage, and Handling

### Inspect each shipment of material and timely replace any damaged materials.

### Handle and store materials in their original packaging, and in accordance with the manufacturer’s written instructions. Protect materials from extremes in temperature, exposure to sunlight, and contamination with dirt or other foreign matter.

## Quality Control

### Where applicable, inspect the installed concrete accessories for each pour, rectify any defects, and complete the Concrete Pour Release Form as specified in Section [ ] Cast-in-Place Concrete for review by the Minister. Obtain the Minister’s authorization to proceed prior to ordering concrete.

# Products

## Materials

### Provide materials in accordance with the following.

### Joints:

#### Joint filler: [Semi rigid], closed cell PVC foam having the following physical properties:

|  |  |  |
| --- | --- | --- |
| **Property** | **Requirement** | **Test Method** |
| [Density | 48 to 80 kg/m3 | ASTM D1667 |
| Compressive Resistance (25% Deflection) | 80 to 165 kPa | ASTM D1667 |
| Compression Set (Room Temp. 25% Deflection) | 10 to 15% of original height | ASTM D1667 |
| Tensile Strength | 550 to 690 kPa | ASTM D412 |
| Elongation | 70%, minimum | ASTM D412 |
| Water Absorption (% weight) | 15%, maximum | ASTM D1056 |
| Temperature Range | -40 to 65°C | ASTM D746 |
| Weather Resistance | Excellent | ASTM D1499] |

#### Adhesive for joint filler: Compatible with the joint filler and formulated for use on the particular substrate.

#### Joint sealant: [Premium grade, high performance, moisture-cured, 1 component polyurethane-based, non-sag elastomeric sealant in accordance with CAN/CGSB-19.13 or ASTM C920, Grade NS, Class 25].

#### Primer for joint sealant: Suitable primer for adhesion under immersion conditions. Compatible with the joint sealant and formulated for use on the particular substrate. Obtain primer from the joint sealant manufacturer.

#### Bond breaker for joint sealant: [Flexible, extruded closed cell polyethylene foam.] [Polythene tape.]

### Bituminous paint: Emulsified asphalt, mineral colloid type, unfilled, bituminous paint of heavy consistency in accordance with CAN/CGSB-37.2.

### Dirt stops: [Treated Douglas Fir plywood in accordance with CSA-O80 Series and CSA-O121.]

### Concrete adhesive anchors: HY150 System as manufactured by Hilti Ltd., Polyall Epoxy System as manufactured by Ucan Fastening Products Ltd., or Epcon Acrylic 7 System as manufactured by ITW Ramset/Red Head Ltd. Provide [stainless steel] [galvanized steel] anchor rods, nuts, and washers.

### [ ].

# Execution

## Installation

### Install concrete accessories at the locations and to the dimensions specified in the Contract Documents.

### Install concrete accessories in accordance with the manufacturer’s written instructions except as otherwise required in the Contract Documents.

### Joint Filler, Adhesive, Sealant, Primer, and Bond Breaker

#### Provide concrete surfaces that are sound, dry, clean, and free of any oil, grease, or other foreign matter.

#### Butt edges of joint filler tightly against one another without any gaps.

#### Use adhesive to bond joint filler to the surface of the concrete.

#### Prime the sides of the joint slots to receive the joint sealant.

#### Install the bond breaker to prevent the bottom of the sealant from adhering to, and to separate it from, the joint filler.

#### Install and cure the joint sealant at ambient temperatures at or above 10°C.

### Bituminous Paint

#### Apply bituminous paint in accordance with CAN/CGSB-37.3. Provide a finished coating thickness of [2 mm +/- 0.5 mm] unless specified otherwise in the Contract Documents.

#### After its application, protect bituminous paint from exposure to sunlight.

### Install adhesive anchors in accordance with the manufacturer’s written instructions. Drill holes to the required diameter and specified embedment depth, and clean out using a wire brush or compressed air, free of oil. Protect anchors and allow adequate cure time for the adhesive prior to applying loads.

**END OF SECTION**

# General

## References

### Provide reinforcing steel in accordance with the following standards (latest revision) except where specified otherwise.

### American Concrete Institute (ACI).

#### ACI 318 Building Code Requirements for Reinforced Concrete.

### Canadian Standards Association (CSA).

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CSA-A23.3 Design of Concrete Structures.

#### CSA-G30.3 Cold-Drawn Steel Wire for Concrete Reinforcement.

#### CAN/CSA-G30.18 Billet-Steel Bars for Concrete Reinforcement.

#### CSA-W186 Welding of Reinforcing Bars in Reinforced Concrete Construction.

### Reinforcing Steel Institute of Canada (RSIC).

#### RSIC Manual of Standard Practice

### American Society of Testing and Materials (ASTM)

#### ASTM A775/A775M Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

### Concrete Reinforcing Steel Institute (CRSI)

#### Fusion-Bonded Epoxy Coating Applicator Plant Certification Program

## Submittals

### Provide the following submittals.

### Shop Drawings:

#### Shop drawings at least 30 days prior to fabrication. Do not commence fabrication until the shop drawings have been reviewed by the Minister.

#### Indicate lists of quantities and weights of reinforcing steel; details of bent bars; diameters, spacings, and locations of reinforcing steel with identifying code marks to permit correct placement without reference to the Contract Drawings; and locations and details of splices. Prepare reinforcing steel shop drawings in accordance with the RSIC Manual of Standard Practice.

### Certified copy of mill test reports of reinforcing steel showing physical and chemical analysis results at least 30 days prior to fabrication.

### Copy of the CRSI Fusion-Bonded Epoxy Coating Applicator certification for the plant.

### Manufacturer’s written instructions for [installing mechanical splices] [repairing damaged epoxy coating] prior to performing the work.

## Delivery, Storage, and handling

### Inspect each shipment of material and timely replace any damaged materials.

### Store reinforcing steel above ground on platforms, skids or other support in separate bundles with identifying tags or marks that permit easy identification and handling. Protect reinforcing steel from mechanical damage and from exposure conditions that may produce rust. Prevent reinforcing steel from becoming coated with materials that would adversely affect the bond.

### Handle epoxy-coated reinforcing steel with non-metallic slings and spreaders to prevent bar-to-bar abrasion and excessive sagging of bundles. Do not drop or drag epoxy-coated reinforcing steel. Do not store epoxy-coated reinforcing steel on-Site for more than 120 days, and limit exposure to sunlight by covering with opaque polyethylene sheeting or other protective material as authorized by the Minister.

## Quality Control

### Inspect the finished reinforcing steel placement for each pour, rectify any defects, and complete the Concrete Pour Release Form as specified in Section [3300] [3305] Cast-in-Place Concrete for review by the Minister. Obtain the Minister’s authorization to proceed prior to ordering concrete.

### Employ a manufacturer certified under the CRSI Fusion-Bonded Epoxy Coating Applicator Plant Program to apply the epoxy coating on the reinforcing steel.

# Products

## Materials

### Provide materials in accordance with the following.

### Reinforcing steel: Billet-steel deformed bars in accordance with CAN/CSA G30.18, Grade 400 [for 15M bars and larger, and Grade 300 for 10M bars].

### Tie wire: Cold-drawn annealed steel wire ties in accordance with CSA-G30.3. Minimum gauge no. 16. [Provide plastic-coated tie wire for epoxy-coated reinforcing steel.

### Chairs, bolsters, bar supports, and spacers: In accordance with CAN/CSA-A23.1.

### Epoxy-coated reinforcing steel: In accordance with ASTM A775/A775M, Grade [ ]. Film thickness of epoxy coating, after curing, to be 175 μm to 300 μm.

### Mechanical splices: In accordance with ACI 318, capable of developing a minimum of 125% of the yield strength of the reinforcing bar.

## Fabrication

### Fabricate reinforcing steel in accordance with the applicable clauses of CAN/CSA-A23.1 and the RSIC Manual of Standard Practice.

### Obtain the Minister’s authorization for locations or additions of splices other than those specified on the Contract Drawings.

### Detail lap lengths and bar development lengths in accordance with CSA-A23.3. Provide Class B tension lap splices unless otherwise specified in the Contract Documents.

# Execution

## Placement

### Place reinforcing steel in accordance with CAN/CSA-A23.1.

### Place reinforcing steel as specified in the Contract Documents.

### Co-ordinate and schedule the installation of inserts, sleeves, anchors, conduits, waterstops, and other items to be embedded in concrete to avoid interference and delays with the placement of reinforcing steel.

### Before placement, clean the surface of the reinforcing steel and the surface of any metal supports of dirt, grease, and heavy, flaky rust and mill scale that can be removed by firm rubbing or equivalent treatment, or other foreign substances, which, in the opinion of the Minister, are objectionable. After placement, maintain the reinforcing steel in a clean condition until completely embedded in concrete.

### Accurately place and secure reinforcing steel and any other items in position so they are not displaced during concrete placement. Prevent disturbance of the reinforcing steel in concrete that has already been placed.

### Obtain the Minister’s authorization prior to incorporating any reinforcing steel splices that are not specified in the Contract Documents.

### Do not use reinforcing steel as support for ramps, runways, walks, platforms, or other such purposes during construction.

### Provide metal chairs, metal hangers, metal spacers, or other satisfactory metal supports for supporting reinforcing steel for walls and the underside of exposed slabs [except use plastic chairs, galvanized metal or epoxy-coated metal supports and spacers for epoxy-coated reinforcement]. For reinforcing steel adjacent to forms, use plastic chairs, galvanized metal or epoxy-coated metal - supports and spacers to maintain concrete clear cover and minimize the potential for staining of permanently exposed concrete surfaces In slabs placed on grade where the underside is not permanently exposed, use precast concrete supports that are specifically constructed for this purpose with the same properties as the concrete required at this location and properly cured. Use other types of supports subject to the authorization of the Minister.

### Provide clear concrete cover as follows:

###  - [Concrete cast directly against earth: 100 mm.

###  - Concrete cast directly against foundation concrete or insulation: 70 mm.

###  - Concrete along water passages: 70 mm.

###  - Concrete exposed to weather or earth: 70 mm.

###  - Concrete at Joint Faces: 50 mm.]

### Maintain the specified concrete cover for the reinforcing steel during concrete placement.

### Cut back any metal supports that are exposed or protruding through the hardened concrete surface at least 25 mm, and repair the concrete in accordance with Section [3300] [3305] – Cast-in-Place Concrete.

## Mechanical Splicing

### Install mechanical splices in strict accordance with the manufacturer’s written instructions and only at the locations specified in the Contract Documents, or as authorized by the Minister.

### Use bar end gauges and profile gauges to verify the thread quality. Use a torque wrench to install the splices.

### Provide plastic end and internal coupler protectors to protect the threads and couplers from contamination and damage.

## Field Bending and Welding

### Do not field bend or field weld reinforcing steel without authorization from the Minister.

### When field bending is authorized by the Minister, use a bending machine without heat, applying a slow steady pressure.

### When field welding is authorized by the Minister, weld in accordance with CSA-W186.

### Replace reinforcing steel that develops cracks or splits.

## Field Touch-Up

### Touch-up damaged and cut ends of epoxy-coated reinforcing steel to provide a continuous epoxy coating. Prepare surface and apply epoxy coating in accordance with the manufacturer’s written instructions.

**END OF SECTION**

# General

## Forms

### The following form is appended hereto and forms part of this section.

### **Number Title**

### 03300.01 Concrete Pour Release Form

## References

### Provide cast-in-place concrete work in accordance with the following standards (latest revision) except where specified otherwise.

### American Concrete Institute (ACI).

#### ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

#### ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete.

### American Society for Testing and Materials (ASTM).

#### ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete.

#### ASTM C295/C295M Standard Guide for Petrographic Examination of Aggregates for Concrete.

#### ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

#### ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete.

### Canadian Standards Association (CSA).

#### CAN/CSA-A3000 Cementitious Materials Compendium.

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CAN/CSA-A23.2 Methods of Test for Concrete.

#### CSA-A23.3 Design of Concrete Structures.

## Submittals

### Provide the following submittals.

### Cementitious Materials:

#### Details of the source of Portland and blended hydraulic cement and the manufacturer’s recent physical and chemical test data including total alkali content expressed as Na2O equivalent, prior to the trial mix program.

#### Details of the source of fly ash and the manufacturer’s recent physical and chemical test data including total alkali content expressed as Na2O equivalent, prior to the trial mix program.

### Mix Design by the Contractor: Mix designs including the results of the trial mix program as specified in clause 1.4.3, at least 10 days prior to placement of concrete. Have mix designs stamped by a specialist concrete materials engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

### Aggregates:

#### The source of concrete aggregates which will be used for the Work for the duration of the Contract within 30 days following the date of the Letter of Acceptance.

#### The results of the petrographic analysis and the results of tests specified in clause 1.4.1 prior to commencing the trial mix program and delivering any aggregate to the Site. Results of tests conducted during progress of the work within 24 hours after completion of the tests.

### Batch Plant:

#### A detailed description of the proposed batch plant including location, equipment and layout, production capacity, measures for pre-cooling concrete, delivery equipment, and water supply system within 30 days following the date of the Letter of Acceptance.

#### Certification, by a CSA certified materials engineering and testing company, that the batch plant equipment has been calibrated and meets the requirements of CAN/CSA-A23.1 at least 15 days prior to any concrete batching operations.

#### Computerized batch records including the mass or volume of each material batched per cycle upon completion of concrete placement for each pour, or upon request by the Minister.

### Concrete Placement:

#### Details of procedures and equipment for hot and cold weather concreting at least 15 days prior to concrete placement.

#### Shop Drawings of hoarding structures for “Record Purposes Only” at least 15 days prior to undertaking such work. Where required by Regulatory Requirements, have the hoarding structure design Shop Drawings stamped by a Professional Engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

#### A concrete placing schedule at least 15 days prior to concrete placement. Update the schedule as required by the Minister during the course of the Work.

#### Delivery tickets at the point of placement as soon as the batch is delivered.

### Concrete Compressive Strength Tests:

#### Compressive strength test results within 48 hours of the break date.

### Concrete Finishing and Repairs:

#### A detailed description of the proposed equipment and procedure for placing, consolidating, and finishing concrete at least 15 days prior to concrete placement.

#### A detailed description of the proposed procedure and materials for repairing defects in the concrete at least 48 hours prior to undertaking repairs.

### Concrete Pour Release Forms: Completed concrete pour release forms at least 24 hours prior to ordering concrete.

## Quality Control

### Quality Control Program

#### Provide a quality control program to confirm that the specified requirements will be consistently attained throughout the Work. Incorporate the specified testing, and any additional testing or measures required by the Contractor.

#### Provide experienced qualified supervisors to oversee quality control throughout the aggregate production; and batching, placement, compaction, curing and protection, and repair of concrete.

#### Engage an independent CSA certified and qualified concrete testing laboratory, with a permit to practice in the Province of Alberta, to sample and test concrete aggregates and concrete. Use ACI or CSA certified testers with extensive related experience to conduct field sampling and testing of concrete.

### Aggregate Tests by the Contractor:

#### Perform a petrographic analysis by an experienced qualified petrographer in accordance with ASTM C295/C295M, and indicate the acceptability of the aggregate for use in concrete specified in the Contract Documents based on Figure 1 of CAN/CSA-A23.2–27A, prior to commencing the trial mix program.

#### Test concrete aggregates during production to confirm that it meets the specified requirements.

#### Conduct a minimum of 1 of each of the following tests prior to the trial mix program [and repeat the following tests for every [2000] m3 of concrete produced for the Work] unless specified otherwise.

##### Material finer than 80 μm: In accordance with CAN/CSA-A23.2–5A. [Conduct a minimum of 1 test for every 500 m3 of concrete produced for the Work].

##### Sieve analysis: In accordance with CAN/CSA-A23.2–2A.

##### Clay lumps: In accordance with CAN/CSA-A23.2–3A.

##### Low-density material: In accordance with CAN/CSA-A23.2–4A.

##### Relative density and absorption of fine aggregate: In accordance with CAN/CSA-A23.2–6A.

##### Organic impurities: In accordance with CAN/CSA-A23.2–7A.

##### Soundness: In accordance with CAN/CSA-A23.2–9A.

##### Relative density and absorption of coarse aggregate: In accordance with CAN/CSA-A23.2–12A.

##### Resistance to degradation by abrasion and impact: In accordance with CAN/CSA-A23.2–16A and CAN/CSA-A23.2–17A.

#### Independent of the aggregate’s conformance to test requirements, the Minister may reject the aggregate on the basis of the performance of similar aggregates used in concrete production from the same source on previous structures.

### Mix Designs and Testing by the Contractor:

#### Engage an independent CSA certified materials engineering and testing company to select concrete mix proportions and conduct a trial mix program using the batch plant that will be used for concrete production for the Work.

#### Proportion concrete mixes in accordance with ACI 211.1. Select proportions to provide the necessary placeability, density, strength, durability, and workability, and to limit the heat generated during hydration. Do not allow the total alkali content of concrete, determined by multiplying the cement content of the concrete mix expressed as kg/m3 by the total alkali content of the cement, and from admixtures to exceed [3] kg/m3.

#### Where placement by pumping is permitted by the Contract Documents, obtain a pumpable concrete mix by using the appropriate gradations of fine and coarse aggregates, admixtures, and properly sized pumping equipment rather than by increasing the volume of fine aggregate as compared to an equivalent non–pumped mix proportioned in accordance with ACI 211.1.

#### Conduct a trial mix program for each class of concrete using a range of ingredient proportions. Obtain cement, fly ash, admixtures, and aggregates for the trial mixes from the same source that will be used for concrete production for the Work.

#### Conduct tests on the trial mixes to verify that the admixtures are compatible with all mix ingredients.

#### Conduct tests on the proposed mix design including those required to determine the proportions of ingredients, slump, unit mass, yield, air content, 7–day and 28–day compressive strengths, workability, and the calculated adiabatic temperature rise. [After the 28–day compressive strength test, provide a plot of the compressive strength versus log time including the projected 90–day strength.]

#### The Minister will authorize concrete production based on the results of satisfactory compressive strength test plots. Notwithstanding the Minister’s authorization to proceed with concrete production, the Contractor is responsible for meeting all of the specified requirements.

### Concrete Sampling and Testing by the Contractor:

#### Sample plastic concrete for testing purposes in accordance with CAN/CSA-A23.2-1C. Obtain plastic concrete for testing at the point of placement.

#### Compressive strength tests:

##### Compressive strength test cylinders will be nominal [100 mm diameter by 200 mm] [150 mm diameter by 300 mm]. Make, and cure including field cure, and transport concrete test cylinders in accordance with CAN/CSA-A23.2-3C.

##### One compressive strength test will consist of testing [6] cylinders of which 2 will be tested at 7 days, 2 at 28 days, [and 2 at 90 days]. Not less than 1 strength test will be made for each 40 m3, or portion thereof, of each class of concrete placed in any given day.

#### Air Content Tests: In accordance with CAN/CSA-A23.2–4C. For each pour, conduct air content tests for the initial batches of each class of concrete until consistent results meeting the specified requirements are obtained, and whenever strength test cylinders are taken.

#### Slump Tests: In accordance with CAN/CSA-A23.2–5C. For each pour, conduct slump tests for every second air test, and whenever a strength test is taken.

#### Concrete Temperature Measurements: By placing a thermometer in the concrete after sampling at the point of placement.

### Complete Concrete Pour Release Forms specified in clause 1.1 for review by the Minister. Obtain the Minister’s authorization to proceed prior to ordering concrete.

### Record the following information on the delivery tickets of each batch of concrete from the batching plant.

#### Slip serial number and date.

#### Class of concrete.

#### Specified 28–day [or 90–day strength].

#### Type of cement and a list of all admixtures.

#### Time of loading or first mixing of cement, fly ash, and aggregate.

#### Time the load arrived at the placement point.

#### Time the discharge of load was started.

#### Time the discharge of load was completed.

#### Concrete temperature during placing.

### Have a technical representative from the curing compound manufacturer on-Site to demonstrate the concrete surface requirements and application techniques. Advise the Minister at least 24 hours prior to the demonstration.

## Quality Assurance

### General

#### The Minister will conduct quality assurance testing of concrete and concrete aggregates during the course of the Work.

#### The frequency of quality assurance testing will be as determined by the Minister.

#### The Minister will conduct random inspections of aggregate stockpiles to check for segregation and contamination. Reprocess or remove any material that, in the opinion of the Minister, is unsuitable.

### Concrete Sampling and Testing by the Minister

#### Provide the Minister with access to aggregate source, stockpiles, and batch plant, and point of placement for the purpose of sampling and inspecting materials.

#### At the batch plant, provide suitable facilities including platforms, tools, and equipment to permit samples of materials to be readily obtained by the Minister from each of the batchers. Temporarily stop batching to allow for sampling.

#### The Minister will sample plastic concrete in accordance with CAN/CSA-A23.2-1C.

#### Compressive Strength Tests: In accordance with CAN/CSA-A23.2-9C

#### One compressive strength test will consist of testing [6] cylinders of which 2 will be tested at 7 days, 2 at 28 days, [and 2 at 90 days]. Not less than 1 strength test will be made for each 40 m3, or portion thereof, of each class of concrete placed in any given day.

#### Air Content Tests: In accordance with either CAN/CSA-A23.2–4C. An air content test will be conducted whenever strength test cylinders are taken.

#### Slump Tests: In accordance with CAN/CSA-A23.2–5C. A slump test will be taken whenever a strength test or air content test is taken.

#### Concrete Temperature Measurements: By placing a thermometer in the concrete after sampling at the point of placement.

#### Aggregate Tests: In accordance with CAN/CSA-A23.2.

## Concrete Compressive Strength Requirements

### Specified concrete compressive strength will be based on 28–day strengths [for Class ] [and 90–day strengths for Class ] concrete. Test results will be evaluated by the Minister in accordance with CAN/CSA-A23.1.

### If concrete placed in the Work fails to meet any of the requirements set out herein, the Minister may order that 1 or more of the following courses of action be carried out:

#### The mix that failed is redesigned, and other mix designs are reviewed.

#### Cores are drilled from the portions of the structure in question and tested in accordance with CAN/CSA-A23.2–14C.

#### The structure or structural elements in question are load tested in accordance with CSA-A23.3.

#### In-place strength tests are conducted using non-destructive methods.

#### Defective concrete is removed and replaced.

### When the results of 7–day strength tests for concrete placed in the Work indicate that the compressive strength may fall below the specified strength, the Minister may require that changes be made in the mix proportions.

# Products

## Materials

### Provide materials in accordance with the following.

### Cement: [Type GU, General Use Hydraulic Cement] [Type HS, High Sulphate Resistant Hydraulic Cement or Type HSb, Blended High Sulphate Resistant Hydraulic Cement], in accordance with CAN/CSA-A3000. Portland cement incorporated to have a total alkali content less than 0.65% (Na2O equivalent). Provide cement from 1 manufacturing source throughout the Contract for consistent quality and compatibility with all concrete materials.

### Fly AshI: In accordance with CAN/CSA-A3000 with a total alkali content less than 4.5% (Na2O equivalent), . Provide Class F fly ash with an oxide (CaO) content less than 8%, or Class CI fly ash with an oxide (CaO) content of between 8% and 20%. Provide fly ash from the same source throughout the Contract for consistent quality and compatibility with all concrete materials.

### Admixtures:

#### From the same manufacturer for compatibility between air–entraining agent, superplasticizer, and water-reducing agent. Conduct tests and trial mixes to verify that admixtures are compatible with all mix ingredients. Provide liquid type admixtures. Provide type WN water reducing agent when required.

#### Air-entraining admixture: In accordance with ASTM C260/C260M.

#### Chemical admixtures: In accordance with ASTM C494/C494M.

#### Do not use calcium chloride or any admixture formulated with calcium chloride.

### Water: Clean and free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis, and other deleterious substances, and in accordance with CAN/CSA-A23.1. Obtain permits as required to use water from a natural source.

### Curing Compound: Do not use curing compound unless authorized by the Minister. When authorized, provide a [clear] [white pigmented] compound in accordance with ASTM C309 Type 1.

### Fine Aggregates:

#### In accordance with CAN/CSA-A23.1 consisting of clean, hard, dense, durable, uncoated rock fragments.

#### Gradation FA1. No more than 45% of the material is to be retained between any 2 consecutive sieves.

#### Where placement by pumping is permitted by the Contract Documents, the percentage passing the 315μm sieve is to be between 15% and 30%, and between 5% and 10% for the 160μm sieve.

#### Fineness modulus is to be between 2.3 and 3.1 and must not vary more than +/-0.20 from the value used in the accepted mix design.

### Coarse Aggregates:

#### In accordance with CAN/CSA-A23.1 consisting of natural gravel, crushed rock, or a combination of both, and to consist of clean, hard, dense, durable, uncoated rock fragments.

#### Provide [Group I 40–5 nominal size of aggregate]. To prevent segregation, stockpile and batch coarse aggregates in 2 or more separate sizes selected from, Groups I and II. Provide [40–5 aggregate consisting of a blend of 20–5 aggregate from Group I and 40–20 aggregate from Group II].

#### Wash coarse aggregates during processing and stockpile separately at the batch plant stockpile areas.

## Concrete Mixes

### Provide the classes of concrete as follows, at the locations specified in the Contract Documents.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Class of Concrete** | **Specified Compressive Strength (MPa)** | **Fly Ash by Mass of Cementitious Materials(%)** | **Nominal Size of Coarse Aggregate (mm)** | **Maximum Water/Cementing Materials Ratio** | **Air Content(%)** | **Specified Slump (mm)** | **General Location** |
| [Structural Concrete Class A1] | [30 @ 28 days] | [≥25 - Class F Fly Ash][≥30 - Class CI Fly Ash] | [40–5] | [0.45] | [4–7] | [60 +/- 20] | [ ] |
| [Structural Concrete Class B1] | [30 @ 90 days] | [≥25 - Class F Fly Ash][≥30 - Class CI Fly Ash] | [40–5] | [0.45] | [4–7] | [60 +/- 20] | [ ] |
| Foundation Concrete | 15 @ 28 days | [≥25 - Class F Fly Ash][≥30 - Class CI Fly Ash] | [40–5] | [0.55] | [4–7] | [Max. 100] | [Between foundation soils and structural concrete.] |

Notes: Cementitious materials consist of cement and fly ash.

# Execution

## Aggregates

### Stockpiling and Handling:

#### Fine and coarse aggregates stockpiling operations are subject to review and authorization by the Minister.

#### Strip topsoil and undesirable overburden material in the aggregate stockpile areas. Where stripping fails to expose a suitable granular material for the stockpile base, grade the area to form a 2% slope and place granular material to a thickness of 300 mm. Provide surface drainage to prevent any accumulation of water in the area.

#### Use stockpiling methods that minimize segregation, aggregate breakage, and contamination.

#### To reduce segregation, separately stockpile coarse aggregates into several size fractions and batch these fractions separately.

#### Maintain a minimum separation distance of 10 m between stockpiles in order to prevent the intermixing of different aggregate sizes. Provide additional measures, as authorized by the Minister, to prevent separation of fine aggregates due to wind, and to prevent contamination with blow dirt.

#### Remove and transfer fine and coarse aggregates from the stockpiles to the batching or conveying equipment by front-end loader machines, power shovels, or similar equipment. Provide a backup loading unit at the plant in the event of breakdown of the primary unit. Do not use crawler or pneumatic-tired equipment for pushing coarse aggregate off the stockpiles to the conveying equipment. Work the stockpiles from bottom to top.

### Moisture Content:

#### Provide adequate drainage time prior to transferring aggregates into the batch plant bins.

#### Maintain the moisture content of the batched aggregates within a range of 1% during any 1 hour of continuous plant operation. The maximum moisture content of aggregates delivered to the batch plant stockpiles cannot exceed 6% (based on saturated surface dry weights) for fine aggregates and 3% for coarse aggregates.

## Concrete Production

### General

#### Produce concrete in accordance with CAN/CSA-A23.1 unless specified otherwise.

#### During progress of the Work, review the mixes and make necessary adjustments if mixes are found to provide unsatisfactory results.

#### Do not commence production of concrete for any pour unless there are sufficient quantities of mix ingredients at the batch plant to complete the entire pour. Do not commence with concrete production for any pour until satisfactory evidence that this condition has been met has been provided, and only after authorization to proceed has been provided by the Minister.

### Batching Plant

#### Provide a batching plant meeting the following requirements.

#### Semi-automatic weigh batching system as defined in ACI 304R [at the Site], or [within a 30 km maximum haul distance from the Site].

#### A manufacturers rated capacity of [40] m3 per hour or greater.

#### Out of tolerance alarms that are activated if an over or under weight occurs in any mix material.

#### Computerized batching system capable of automatically recording and printing any adjustments along with the target mass; the actual mass; and, any out of tolerance alarms, of individual materials for each batch; and stopping the batching sequence if an out of tolerance alarm occurs.

#### Weigh scales that are accurate within the tolerances specified in CAN/CSA-A23.1. Arrange weigh scales so that they are clearly visible to the plant operator at all times during the batch and discharge cycles.

#### Interlocked batching controls that prevent a new batching cycle from beginning until all batchers are completely empty, the scales register zero, and the discharge gates are closed. The filling and discharge valves of the water batching device are interlocked so that the discharge valve cannot be operated until the filling valve is fully closed. Provide valves that do not leak.

#### Permits rapid adjustments for making changes in the mix proportions, and compensates for variations in the moisture content of the aggregates.

#### Control system that can accommodate a minimum of [3] preset mixes and permits changing from one mix to another with minimum delay.

#### Heated control room supported independently from the plant to reduce vibrations, dust, and noise.

#### Heated enclosure that can maintain a minimum temperature of 7°C to house the mixing and batching equipment, water heaters, and the water and admixture storage tanks, and to protect the weighing and measuring devices from wind, rain, and snow.

#### In-plant storage facilities consisting of a minimum of [5 storage bins (1 cement, 1 flyash, 1 fine aggregate, and 2 coarse aggregate)], located above ground level. Bins are constructed so that material does not hang up or spill from one bin into another, and are equipped with clamshell or undercut radial type bin gates that discharge or convey aggregate into the weight batcher.

#### Heating equipment with sufficient capacities to heat the water and, if necessary, the aggregates so that the concrete will meet the specified temperature requirements.

### Batch Plant Operation

#### Do not charge the batch plant with frozen aggregates. Maintain the temperature of aggregates in bins at the batching plant above 0°C at all times.

#### Separately weigh or measure materials into individual weigh hoppers or measuring dispensers. Do not use cumulative weighing unless the batch plant has computerized batch adjustment capabilities.

#### Adjust coarse and fine aggregate batches for undersize and oversize aggregate within each aggregate class.

#### Maintain the temperature of the concrete admixtures above freezing. Agitate the liquid admixtures to prevent settling and to ensure uniformity. Provide admixture-measuring devices with sufficient capacity to measure the full quantity required for each batch.

## Mixing and Transporting Concrete

### Mix and transport concrete in accordance with CAN/CSA-A23.1 unless specified otherwise.

### Use mixers that are capable of producing concrete of a thoroughly mixed and uniform mass, and of discharging the concrete so that the uniformity requirements of CAN/CSA-A23.1 are met. Replace any mixer that does not produce concrete of the specified uniformity.

### Use mixers or agitating equipment to deliver concrete from the batch plant to the point of placement. Use agitating speeds recommended by the agitating equipment manufacturer.

### Provide sufficient numbers of truck mixers and monitor and schedule their departure times from the batch plant and their arrival times at the point of placement to avoid waiting periods or delay in arrival. Provide equipment for direct communication between the Contractor’s personnel at the job site and the batching plant during concrete placement.

## Concrete Temperatures

### The permissible concrete temperature at the point of placement is as follows. For structure sections of varying thickness, use the maximum thickness to determine temperature requirements.

|  |  |
| --- | --- |
| **Thickness of Structure Section (m)** | **Permissible Concrete Temperature at the Point of Placement (°C)** |
| **Minimum** | **Maximum** |
| < 0.3 | 10 | 25 |
| 0.3 to ≤ 1 | 10 | 25 |
| > 1 to ≤ 2 | 5 | 20 |
| > 2 | 5 | 15 |

### Do not use concrete that fails to meet the permissible temperatures at the point of placement.

### Devise and provide all necessary measures for pre-cooling concrete to achieve the permissible concrete temperature, at the point of placement.

### Pre-cooling measures may include 1 or more of the following:

#### Chilling the mixing water by refrigeration or ice.

#### Cooling of coarse aggregates by shading stockpiles and storage bins, by evaporation through vacuum, by inundation with chilled water, or by blowing chilled air through batching bins.

### To avoid cracking of the concrete due to sudden temperature change, do not remove weather protection measures until the concrete has cooled to the temperature differential specified in CAN/CSA-A23.1, Table 21.

## Hot Weather Requirements

### Hot weather requirements apply when the air temperature is at or above 25°C, or is forecast to rise to 25°C within 24 hours of placement.

### Protect formwork, reinforcement, and concrete equipment from the direct rays of the sun, or cool by fogging and evaporation. Dampen subgrade surfaces prior to concrete placement.

### Provide adequate personnel and equipment to transport, place, consolidate, and finish the concrete at the fastest possible rate. Obtain prior authorization from the Minister for the proposed equipment and procedures for hot weather concreting.

### Provide protection from drying in accordance with CAN/CSA-A23.1.

## Cold Weather Requirements

### Cold weather requirements apply when the air temperature is at or below 5°C, or is forecast to fall below 5°C within 24 hours of placing.

### When concrete is to be placed in cold weather, have all materials and equipment needed for adequate protection and curing on hand and ready for use before concrete placement is started. Obtain prior authorization from the Minister for the proposed enclosures, equipment, and procedures for cold weather concreting.

### Do not place concrete against any surface that has a temperature of less than 5°C. Remove all snow and ice. Preheat such surfaces for 24 hours or as required to obtain surface temperatures of 5°C minimum, whichever is longer, prior to placing concrete.

### Design and construct heating and hoarding protection measures including heated enclosures, coverings, insulation, or a suitable combination of these methods in accordance with CAN/CSA-A23.1.

### Inspect heating and hoarding measures at least every 4 hours and verify that enclosures, coverings, and insulation are in place, there is adequate heater fuel, and the specified temperatures are being maintained.

### Provide a sufficient number of adequately sized and properly vented heaters. Do not place heaters at locations that may cause rapid drying of freshly placed concrete. Use fans to constantly circulate warm air within the enclosure. Do not use tiger torches or other open flame burners as heaters.

## Placing of Concrete

### General

#### Place concrete in accordance with CAN/CSA-A23.1 [except that the placement of concrete by pumping methods is only permitted as specified in clause 3.7.2].

#### Do not schedule or place concrete during periods that have a high probability of rain. Provide adequate materials on-Site to protect concrete from the harmful effects of rain or snow during placement.

#### Convey concrete from the point of supply to its final position as rapidly as practicable, by methods that will prevent segregation, loss of ingredients, or damage by exposure to the elements.

#### Completely discharge and place concrete within the forms no later than 90 minutes after the cement has been mixed with the water or aggregates. Reduce the time between batching and complete discharge to 60 minutes when the ambient air temperature exceeds 25°C.

#### Place the concrete in a continuous operation until the unit section is completed. Use a concrete placing rate that ensures each layer is placed while the previous layer is soft or plastic; the two layers become monolithic by penetration of the vibrators; and cold joints are not produced.

#### Do not place concrete faster than the rate for which the forms have been designed or at which the concrete can be properly consolidated. Regulate the deposition of concrete such that it is properly consolidated in horizontal layers 500 mm in thickness with minimum lateral movement.

#### Use placing equipment of such size, design, and condition so as to steadily supply concrete at the point of placement. Provide equipment that has devices necessary to permit the prompt and complete discharge of concrete without segregation and with the required slump. If bottom-dump buckets are used, provide a positive means of regulating the amount and rate of concrete deposition in each dumping position.

#### Limit the unrestricted drop of concrete to less than 1.5 m. If the drop of concrete is in excess of 1.5 m, use chutes or trunks to prevent segregation of the materials.

#### Maintain all placing equipment free from hardened concrete and foreign materials and clean such equipment at frequent intervals. Do not use conveying equipment made from aluminum alloys.

#### Place and finish each unit section in a continuous full width operation between the specified construction joints. Do not pour concrete against a previously poured concrete monolith until the existing monolith is at least 7 days old.

#### If concrete is to be placed at night, supply a lighting system that will illuminate the inside of the forms, and provide a safe workplace.

#### Do not perform concreting under water unless authorized by the Minister.

### Placing Concrete by Pumping:

#### Placing concrete by pumping methods will only be permitted [for vertical walls].

#### Supply pumping equipment that is capable of pumping the specified concrete without adjustment to the accepted mix designs. Conduct full-scale field tests to demonstrate that the equipment can consistently deliver the concrete from the pump location to the point of deposition at the required rate and with the specified quality requirements prior to using such equipment for concrete placement. The pipeline set-up, including lengths, fittings, and booms used in the tests, is to be representative of the maximum height and distance to be encountered during placement. Do not use aluminum piping for concrete pumping.

#### Precede each pumping operation by pumping sufficient mortar to fully lubricate the pump, pipes, hoppers, and other equipment through which concrete will pass. The mortar is to consist of the concrete mix being placed without the coarse aggregate. Do not place the mortar in the Work.

#### Supply concrete at a rate that provides for continuous pumping. Commence placement at the farthest point from the pump.

#### Whenever concrete is being placed by pumping, provide a standby concrete pump unit or other appropriate placement equipment at the Site as authorized by the Minister.

## Consolidating Concrete

### Uniformly and thoroughly compact concrete as it is being placed. Use vibrators of the proper size, frequency and amplitude, supplemented by hand spading and tamping when required, to secure a dense, homogeneous concrete, a good bond with the reinforcing steel and embedded items, and a smooth formed surface free of air pockets and surface blemishes.

### Use the following for choosing internal vibrators:

|  |  |  |  |
| --- | --- | --- | --- |
| **Application** | **Head Diameter(mm)** | **Frequency(VPM)** | **Amplitude(mm)** |
| Slabs and Walls Less Than 400 mm ThickAll Other Construction | 30 – 6550 – 90 | 8500 – 125008000 – 12000 | 0.5 – 1.00.6 – 1.3 |

### Do not use concrete vibrators for moving concrete laterally. Thoroughly and systematically vibrate concrete in the previously placed layer before placing the overlying layer.

### Operate vibrators in a vertical position and allow the vibrating head to penetrate the top portion of the underlying concrete at a uniform spacing over the entire area of placement. Maintain the distance between insertions at approximately 12 times the radius of action of the vibrator such that the area under vibration overlaps the just-vibrated area by several centimetres. Do not allow segregation of the ingredients or laitance to appear on the surface.

### Do not allow vibrators to disturb embedded parts [or instrumentation].

### Provide spare vibrators at the point of placement to maintain production.

## Construction Joints

### Protect waterstop and other items prior to preparing construction joints. Prepare construction joints to provide an adequate bond between successive and adjacent lifts of concrete. Roughen the construction joint interface to an amplitude of 5 mm. Use air-water cutting, sandblasting, high pressure water jets, or other authorized means to remove all laitance, unsound mortar, and inferior surface concrete, and to expose clean, sound, fine aggregate without undercutting the edges of coarse aggregate particles.

### Use air-water cutting on horizontal construction joints only. Allow concrete to harden sufficiently to prevent undercutting. Cut the surface with a strong jet of air-water at approximately 0.7 MPa. After cutting, wash and rinse the surface until cloudiness of the wash water is removed. Wash or air-blow the surface again just prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, sandblast before placing the next lift.

### Sandblast the surface after the concrete has hardened and just before forms are erected for the next placement. Wash or air-blow the concrete surface after sandblasting and just prior to placing the succeeding lift to remove all dirt, debris, or other foreign material.

### Use a high-pressure water jet with a minimum pressure of 20 MPa. Delay the use of the high-pressure water jet until the concrete is sufficiently hard. Wash or air-blow the surfaces to remove all dirt, debris, or other foreign material just prior to placing the succeeding lift. If the water jet is incapable of a satisfactory cleaning, clean the surface by sandblasting.

### Dispose of wastewater employed in cutting, washing, and rinsing of concrete surfaces such that the wastewater does not stain, discolour, or affect exposed surfaces of the structures, or damage the environment.

### Provide a clean concrete joint that is saturated surface dry at the time new concrete is placed on it.

## Concrete Finishing

### General:

#### Construct completed concrete work within the specified surface finish tolerances, or within the structural tolerance specified in Section 03110 – Concrete Formwork, whichever is more stringent. Provide a finished surface that is smooth, uniform in texture, and free from streaks, discoloration, or other imperfections.

#### If the completed concrete work fails to meet the specified surface finish tolerances, modify the properties of concrete, placement and consolidation methods, formwork materials and design, and surface finishing techniques to achieve the specified finish tolerances. Submit details of such modifications for review and authorization by the Minister. Repair completed work to meet the specified tolerances, unless otherwise authorized by the Minister.

### Classification of Surface Irregularities:

#### Local surface irregularities are classified as “abrupt” or “gradual.”

#### Abrupt irregularities mean offsets or fins caused by displaced or misplaced form sheeting, lining, or form sections or by defective form lumber, or improper screeding or trowelling. Abrupt irregularities also include any isolated irregularity in which the maximum dimension of the irregularity perpendicular to the surface is greater than the maximum dimension of the irregularity in the plane of the surface.

#### Gradual irregularities mean bulges or depressions resulting in gradual changes in the concrete surface.

### Measuring Surface Irregularities:

#### Measure irregularities as deviations from a surface, with a straightedge or shaped template authorized by the Minister. Move the position of the straightedge about the irregularity as necessary to locate the point where the maximum height and slope exists. Provide 3 m long straightedges for taking measurements.

#### For irregularities protruding above the surface, place 1 end of the straightedge on top of the irregularity. The height of the irregularity is determined by measuring the gap perpendicular to the straightedge. The length of the irregularity is determined by measuring the distance along the straightedge from the gap to the point of contact at the top of the irregularity. The slope of the irregularity is the ratio of the height to length.

#### For irregularities extending below the surface, place the straightedge across the irregularity. The height of the irregularity is determined by measuring the gap between the straightedge and the surface. The length of the irregularity is the distance along the straightedge from the gap to the point of contact with the surface. The slope of the irregularity is the ratio of the height to length.

#### Check finished concrete surfaces immediately after final working, and again at the end of the curing period and verify their compliance with the specified tolerances.

### Classification of Concrete Finishes:

#### Concrete finishes are designated as follows:

##### F1, F2, and F3 for formed surfaces.

##### U1, U2, U3, and U4 for unformed surfaces.

#### Finishes for Formed Surfaces:

##### F1:

###### Applies to permanently concealed, formed surfaces upon or against which fill or concrete is to be placed.

###### F1 surfaces require no treatment beyond the repair of defective concrete and dry packing of tie-rod holes. Cut back form ties to a minimum depth of 25 mm from the concrete surface.

##### F2:

###### Applies to permanently exposed, formed surfaces except where a F3 finish is required.

###### Limit the height of abrupt surface irregularities to no more than [6 mm]. Limit the height of gradual surface irregularities to no more than [12 mm] and the ratio of height to length to no steeper than [1:8].

###### Immediately after removing forms, repair surface irregularities, thoroughly expose surface voids and other holes by powered wire brushing, dry pack tie-rod holes and surface voids in excess of 10 mm diameter. Cut back form ties to a minimum depth of 25 mm from the concrete surface. Repair defective and damaged areas.

###### Provide a sacked-rubbed finish in accordance with CAN/CSA-A23.1.

##### F3:

###### Applies to formed surfaces exposed to water flow.

###### Limit the height of abrupt irregularities to no more than [3 mm]. Limit the height of gradual irregularities to no more than 6 mm and the ratio of height to length to no steeper than [1:16.]

###### Immediately after removing forms, repair surface irregularities, thoroughly expose surface voids and other holes by powered wire brushing, dry pack tie-rod holes and surface voids that exceed 10 mm in diameter. Cut back form ties to a minimum depth of 25 mm from the concrete surface. Repair defective and damaged areas.

###### Provide a sacked-rubbed finish in accordance with CAN/CSA-A23.1.

#### Finishes for Unformed Surfaces:

##### U1:

###### Applies to permanently concealed unformed surfaces that will be covered by fill or concrete. It is also the first stage for U2 and U3 finishes.

###### Level and screed the concrete surface to produce a uniform surface.

##### U2:

###### Applies to permanently exposed unformed surfaces except where U3 finish is required. It is also the second stage for a U3 finish.

###### Level and screed the concrete surface followed by floating to produce a surface that is uniform in texture and free of screed marks.

###### Limit the height of abrupt irregularities to no more than [6 mm]. Limit the height of gradual irregularities to no more than [12 mm] and the ratio of height to length to no steeper than [1:8.]

##### U3:

###### Applies to unformed surfaces exposed to water flow.

###### Level and screed the concrete surface followed by floating and applying a steel trowel finish to produce a dense uniform surface, free of blemishes, ripples, and trowel marks to the required lines, slopes, and elevations.

###### Limit the height of abrupt irregularities to no more than [3 mm]. Limit the height of gradual irregularities to no more than [6 mm] and the ratio of height to length to no steeper than [1:16.]

##### U4:

###### Applies to unformed surfaces where pedestrian traffic is expected.

###### Level and screed the concrete surface followed by floating and applying a steel trowel finish to produce a dense uniform surface, free of blemishes, ripples, and trowel marks to the required lines, slopes, and elevations. After first trowelling, provide a non-slip surface finish by brooming.

###### Limit the height of abrupt irregularities to no more than [3 mm]. Limit the height of gradual irregularities to no more than [6 mm] and the ratio of height to length to no steeper than [1:16.]

## Curing and Protection

### Maintain all material and equipment required for curing and protection on hand at the Site prior to placing any concrete.

### Do not commence curing until after finishing.

### Commence curing of exposed surfaces as soon as the concrete has hardened sufficiently to prevent surface damage.

### Continuously moist cure all concrete for a minimum duration of 7 consecutive days at an ambient temperature maintained above 10°C.

### Continuously moist cure concrete by covering with absorptive mat or fabric kept wet by using a system of perforated pipes, mechanical sprinklers, porous hoses, or by other methods that keep all surfaces continuously wet. Initially cure formed surfaces by leaving forms in position and keeping such forms continuously wet.

### Do not use curing water that is more than 11°C cooler than the concrete temperature.

### Do not use curing compound [except on slabs as specified in the Contract Documents.]

### If authorized by the Minister, apply curing compounds at a uniform rate by mechanical application methods. Provide complete coverage by applying 2 coats at right angles to each other. Minimum coverage is 0.20 L/m2. Apply curing compound immediately after finishing and as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the compound will be absorbed into the concrete.

## Repair of Concrete

### Examine all concrete surfaces and clearly mark out defective areas to be repaired. Obtain the Minister’s authorization of the delineated repair areas and the proposed method and equipment to be used for the repairs prior to commencing with the work.

### Completely remove all damaged, deteriorated, loosened, or unbonded concrete down to sound concrete. Remove microfractured surfaces resulting from the concrete removal process.

### Sawcut the perimeter of areas requiring concrete removal and replacement perpendicular to the surface to a minimum depth of 25 mm. Do not use any repair method that produces a featheredge.

### Prior to filling, provide a repair area that is clean and saturated surface dry except where the repair technique requires a dry surface.

### Use dry-pack mortar for filling holes left by the removal of form ties, for narrow grooves cut for repair of cracks, and for repair of small honeycombed areas where lateral restraint can be obtained. Pre-soak the repair area, allow the area to attain a saturated surface dry condition, and apply a cement paste bond coat prior to filling with mortar. Dry-pack mortar is to consist of 1 part Portland Cement to 2.5 parts sand, by mass.

### Mortar filling with a polymerized mortar placed under pressure by use of a mortar gun or head box may be used for repairing defects that are too wide for dry-pack filling, too shallow for concrete placement, and no deeper than the far side of the reinforcement that is nearest the surface. [Treat the surface of the concrete to be repaired with a compatible acrylic bonding agent as authorized by the Minister prior to mortar filling.]

### Completely remove honeycombed areas down to sound concrete or to the required depth behind the reinforcing steel, whichever is greater. The depth required beyond the reinforcing steel is 1.5 times the maximum aggregate size of the replacement concrete or 25 mm, whichever is greater. [Treat the surface of the concrete to be repaired with a high percentage solids epoxy bonding agent or acrylic bonding agent as authorized by the Minister prior to concrete replacement.] Construct the repair area slightly proud of the general surface and then grind it to match within the specified tolerances.

### Repair abrupt and gradual irregularities that exceed the specified tolerances by no more than 10 mm by grinding. For finishes F3 and U3, limit the depth of grinding such that no aggregate particles are exposed more than 3 mm in cross section at the finished surface. For finishes F2 and U2, limit the depth of grinding such that no aggregate particles are exposed more than 6 mm in cross section at the finished surface.

### Where surface grinding results or will result in exposure of aggregate particles that exceed the specified limits, or where the abrupt and gradual irregularities exceed the specified tolerances by more than 10 mm, repair the irregularities by removing the concrete to a depth below the reinforcing steel of 1.5 times the maximum aggregate size of the replacement concrete or 25 mm, whichever is greater. Treat and construct the repair area as specified for honeycombed areas.

### Provide replacement concrete that has the same strength and durability characteristics as the adjacent specified concrete. Use cement that provides a finish colour that matches the surrounding concrete surfaces in areas that are permanently exposed.

### Following repairs, promptly initiate curing. Provide completed repair areas that are tightly bonded to the underlying concrete, and are free of shrinkage cracks or hollow void areas.

## Environmental Requirements

### Provide dust collecting devices on cement and fly ash silos.

### Contain all wastewater including that from washing truck mixers or agitators, in settlement ponds. Do not release any water from the settlement ponds until it meets the Regulatory Requirements.

### Provide disposal bins at the Minister’s site laboratory for collecting waste concrete and other test materials. Empty the bins when required by the Minister.

### Place waste rejected concrete and waste materials from settling ponds in waste disposal areas on-Site as authorized by the Minister or off-Site waste disposal facilities.

**END OF SECTION**

**Concrete Pour Release – Form No. 03300.01**

Project Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Contract Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Submittal Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structure: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pour Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pour Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| **List of Work Items** | **Initial Completed and Checked** |
| **Contractor** | **Minister** |
| **Surface Preparation**• Construction Joint Preparation • Subgrade Preparation• Other |  |  |
| **Embedded Parts**• Reinforcing Steel• Embedded Parts• Waterstop• Other |  |  |
| **Curing and Protection**• Curing Requirements• Cold Weather Requirements• Hot Weather Requirements• Other |  |  |
| **Concrete Placement**• Conveying Equipment• Vibrators• Lighting• Equipment Access• Standby Equipment• Other |  |  |
| **Formwork**• Formwork• Shoring• Other |  |  |
| **Installation**• Lines• Elevations• Dimensions• Other |  |  |
| Submitted By: (Contractor) Date: Authorization to Order Concrete: (Minister) Date:  |

# General

## Forms

### The following form is appended hereto and forms part of this section.

### **Number Title**

### 03305.01 Concrete Pour Release Form

## References

### Provide cast-in-place concrete work in accordance with the following standards (latest revision) except where specified otherwise.

### American Concrete Institute (ACI).

#### ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

#### ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete.

### American Society for Testing and Materials (ASTM).

#### ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete.

#### ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

#### ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete.

### Canadian Standards Association (CSA).

#### CAN/CSA-A3000 Cementitious Materials Compendium.

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CAN/CSA-A23.2 Methods of Test for Concrete.

#### CSA-A23.3 Design of Concrete Structures.

## Submittals

### Provide the following submittals.

### Cementitious Materials:

#### Details of the source of Portland and blended hydraulic cement and the manufacturer’s recent physical and chemical test data including total alkali content expressed as Na2O equivalent, at least 15 days prior to placement of concrete.

#### Details of the source of fly ash and the manufacturer’s recent physical and chemical test data including total alkali content expressed as Na2O equivalent, at least 15 days prior to placement of concrete.

### Concrete Aggregates:

#### Provide the following at least 15 days prior to placement of concrete.

#### Result of petrographic examination, by an experienced qualified petrographer in accordance with ASTM C295/C295M, of concrete aggregates obtained from the same source that will be used to produce concrete for the Work. Ensure petrographic examination was performed no more than 180 days prior to the start of concrete delivery to the Site. The result to indicate the acceptability of the aggregate for use in concrete specified in the Contract Documents based on Figure 1 of CAN/CSA-A23.2–27A,

#### Results of concrete aggregate tests specified in clause 1.4.2.

### Mix Design by the Contractor: Mix designs including the results of the trial mix program as specified in clause 1.4.3, at least 15 days prior to placement of concrete. Have mix designs stamped by a specialist concrete materials engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

### Concrete Placement:

#### Details of procedures and equipment for cold weather concreting at least 15 days prior to concrete placement.

#### Shop Drawings of hoarding structures for “Record Purposes Only” at least 15 days prior to undertaking such work. Where required by Regulatory Requirements, have the hoarding structure design Shop Drawings stamped by a Professional Engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

#### Delivery tickets to the Minister at the point of placement as soon as the batch is delivered.

### Concrete Pour Release Forms: Completed concrete pour release forms at least 24 hours prior to ordering concrete.

## Quality Control

### Quality Control Program

#### Provide a quality control program to confirm that the specified requirements will be consistently attained throughout the Work. Incorporate the specified testing, and any additional testing or measures required by the Contractor.

#### Engage an independent CSA certified and qualified concrete testing laboratory, with a permit to practice in the Province of Alberta, to sample and test concrete aggregates and concrete. Use ACI or CSA certified testers with extensive related experience to conduct field sampling and testing of concrete.

### Concrete Aggregate Tests:

#### Provide the following test results of concrete aggregates, obtained from the same source that will be used to produce concrete for the Work, which were performed no more than 120 days prior to the start of concrete delivery to the Site unless otherwise specified.

##### Material finer than 80 μm: In accordance with CAN/CSA-A23.2–5A. Provide test results performed no more than 30 days prior to the start of concrete delivery to the Site unless otherwise specified.

##### Sieve analysis: In accordance with CAN/CSA-A23.2–2A.

##### Clay lumps: In accordance with CAN/CSA-A23.2–3A.

##### Low-density material: In accordance with CAN/CSA-A23.2–4A.

##### Relative density and absorption of fine aggregate: In accordance with CAN/CSA-A23.2–6A.

##### Organic impurities: In accordance with CAN/CSA-A23.2–7A.

##### Soundness: In accordance with CAN/CSA-A23.2–9A.

##### Relative density and absorption of coarse aggregate: In accordance with CAN/CSA-A23.2–12A.

##### Resistance to degradation by abrasion and impact: In accordance with CAN/CSA-A23.2–16A and CAN/CSA-A23.2–17A.

### Mix Designs and Testing by the Contractor:

#### Proportion concrete mixes in accordance with ACI 211.1. Select proportions to provide the necessary placeability, density, strength, durability, and workability, and to limit the heat generated during hydration. Do not allow the total alkali content of concrete, determined by multiplying the cement content of the concrete mix expressed as kg/m3 by the total alkali content of the cement, and from admixtures to exceed [3] kg/m3.

#### Where placement by pumping is proposed, obtain a pumpable concrete mix by using the appropriate gradations of fine and coarse aggregates, admixtures, and properly sized pumping equipment rather than by increasing the volume of fine aggregate as compared to an equivalent non-pumped mix proportioned in accordance with ACI 211.1.

#### Submit test results for the mix design being proposed for concrete at least 10 days prior to placement of concrete. Test results are to include proportions of ingredients, slump, unit mass, yield, air content, 7–day and 28–day compressive strengths, and workability.

### Concrete Sampling and Testing by the Contractor:

#### Sample plastic concrete for testing purposes in accordance with CAN/CSA-A23.2-1C. Obtain plastic concrete for testing at the point of placement.

#### Compressive strength tests:

##### Compressive strength test cylinders will be nominal [100 mm diameter by 200 mm] [150 mm diameter by 300 mm]. Make, and cure including field cure, and transport concrete test cylinders in accordance with CAN/CSA-A23.2-3C.

##### One compressive strength test will consist of testing 4 cylinders of which 2 will be tested at 7 days and 2 at 28 days. Not less than 1 strength test will be made for each 40 m3, or portion thereof, of each class of concrete placed in any given day.

#### Air Content Tests: In accordance with CAN/CSA-A23.2–4C. For each pour, conduct air content tests for the initial batches of each class of concrete until consistent results meeting the specified requirements are obtained, and whenever strength test cylinders are taken.

#### Slump Tests: In accordance with CAN/CSA-A23.2–5C. For each pour, conduct slump tests for every second air test, and whenever a strength test is taken.

### Concrete Temperature Measurements: By placing a thermometer in the concrete after sampling at the point of placement.

### Complete Concrete Pour Release Forms specified in clause 1.1 for review by the Minister. Obtain the Minister’s authorization to proceed prior to ordering concrete.

### Record the following information on the delivery tickets of each batch of concrete from the batching plant.

#### Slip serial number and date.

#### Class of concrete.

#### Specified 28–day strength.

#### Type of cement and a list of all admixtures.

#### Time of loading or first mixing of cement, fly ash, and aggregate.

#### Time the load arrived at the placement point.

#### Time the discharge of load was started.

#### Time the discharge of load was completed.

#### Concrete temperature during placing.

## Quality Assurance

### .1 General

#### .1 The Minister will conduct quality assurance testing of concrete and concrete aggregates during the course of the Work.

#### .2 The frequency of quality assurance testing will be as determined by the Minister.

#### .3 The Minister may conduct random inspections of aggregate stockpiles to check for segregation and contamination. Reprocess or remove any material that, in the opinion of the Minister, is unsuitable.

### .2 Concrete Sampling and Testing by the Minister

#### .1 Provide the Minister with access to aggregate source, stockpiles, and batch plant, and point of placement for the purpose of sampling and inspecting materials.

#### .2 At the batch plant, provide suitable facilities including platforms, tools, and equipment to permit samples of materials to be readily obtained by the Minister from each of the batchers. Temporarily stop batching to allow for sampling.

#### .3 The Minister will sample plastic concrete in accordance with CAN/CSA-A23.2-1C.

#### .4 Compressive Strength Tests: In accordance with CAN/CSA-A23.2-9C. One compressive strength test will consist of testing 4 cylinders of which 2 will be tested at 7 days and 2 at 28 days.

#### .5 Air Content Tests: In accordance with either CAN/CSA-A23.2–4C. An air content test will be conducted whenever strength test cylinders are taken.

#### .6 Slump Tests: In accordance with CAN/CSA-A23.2–5C. A slump test will be taken whenever a strength test or air content test is taken.

#### .7 Concrete Temperature Measurements: By placing a thermometer in the concrete after sampling at the point of placement.

#### .8 Aggregate Tests: In accordance with CAN/CSA-A23.2.

## Concrete Compressive Strength Requirements

### Specified concrete compressive strength will be based on 28–day strengths. Test results will be evaluated by the Minister in accordance with CAN/CSA- A23.1.

### If concrete placed in the Work fails to meet any of the requirements set out herein, the Minister may order that 1 or more of the following courses of action be carried out:

#### The mix that failed is redesigned, and other mix designs are reviewed.

#### Cores are drilled from the portions of the structure in question and tested in accordance with CAN/CSA-A23.2–14C.

#### The structure or structural elements in question are load tested in accordance with CSA-A23.3.

#### In-place strength tests are conducted using non-destructive methods.

#### Defective concrete is removed and replaced.

# Products

## Materials

### Provide materials in accordance with the following.

### Cement: Cement: [Type GU, General Use Hydraulic Cement] [Type HS, High Sulphate Resistant Hydraulic Cement or Type HSb, Blended High Sulphate Resistant Hydraulic Cement] in accordance with CAN/CSA-A3000. Portland cement incorporated to have a total alkali content less than 0.65% (Na2O equivalent). Provide cement from 1 manufacturing source throughout the Contract for consistent quality and compatibility with all concrete materials.

### Fly Ash: In accordance with CAN/CSA-A3000 with a total alkali content less than 4.5% (Na2O equivalent). Provide Class F fly ash with an oxide (CaO) content less than 8%, or Class CI fly ash with an oxide (CaO) content of between 8% and 20%. Provide fly ash from the same source throughout the Contract for consistent quality and compatibility with all concrete materials.

### Admixtures:

#### Provide air-entraining agent, superplasticizer, and water-reducing agent from the same manufacturer for compatibility. Provide liquid type admixtures. Provide type WN water reducing agent when required.

#### Air-entraining admixture: In accordance with ASTM C260/C260M.

#### Chemical admixtures: In accordance with ASTM C494/C494M.

#### Do not use calcium chloride or any admixture formulated with calcium chloride.

### Water: Clean and free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis, and other deleterious substances, and in accordance with CAN/CSA-A23.1. Obtain permits as required to use water from natural sources.

### Aggregates:

#### Fine aggregates: In accordance with CAN/CSA-A23.1 consisting of clean, hard, dense, durable, uncoated rock fragments. Provide gradation FA1.

#### Coarse Aggregates: In accordance with CAN/CSA-A23.1 consisting of natural gravel, crushed rock, or a combination of both, and to consist of clean, hard, dense, durable, uncoated rock fragments. [Provide Group I 20-5 nominal size of aggregate] [Provide 40–5 aggregate consisting of a blend of 20–5 aggregate from Group I and 40–20 aggregate from Group II.]

#### Wash coarse aggregates during processing and stockpile separately at the batch plant stockpile areas.

### Curing Compound: Do not use curing compound unless authorized by the Minister. When authorized, provide a [clear] [white pigmented] compound in accordance with ASTM C309 Type 1.

## Concrete Mixes

### Provide the classes of concrete as follows, at the locations specified in the Contract Documents.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Class of Concrete** | **Specified Compressive Strength (MPa)** | **Fly Ash by Mass of Cementitious Materials(%)** | **Nominal Size of Coarse Aggregate (mm)** | **Maximum Water/Cementing Materials Ratio** | **Air Content(%)** | **Specified Slump (mm)** | **General Location** |
| [Structural Concrete] | [30 @ 28 days] | [≥25 – Class F Fly Ash][≥30 – Class CI Fly Ash] | [20–5] | [0.45] | [5 - 8] | [60+/-20] | [All reinforced concrete.] |
| [FoundationConcrete] | [15 @ 28 days] | [≥25 – Class F Fly Ash][≥30 – Class CI Fly Ash] | [20–5] | [0.55] | [5 - 8] | [Max. 100] | [Between foundation soils and structural concrete.] |

Notes: Cementitious materials consist of cement and fly ash.

# Execution

## Concrete Production

### Production of concrete and the batch plant to be in accordance with CAN/CSA-A23.1 unless specified otherwise.

### Equip batch plant with a minimum of [5 storage bins (1 cement, 1 flyash, 1 fine aggregate, and 2 coarse aggregate)].

## Mixing and Transporting Concrete

### Mix and transport concrete in accordance with CAN/CSA-A23.1 unless specified otherwise.

### Use mixers capable of producing concrete that is thoroughly mixed, of a uniform mass, and of discharging the concrete so that the uniformity requirements of CAN/CSA-A23.1 are met. Replace any mixer that does not produce concrete of the specified uniformity.

### Provide sufficient numbers of truck mixers and monitor and schedule their departure times from the batch plant and their arrival times at the point of placement to avoid waiting periods or delay in arrival. Provide equipment for direct communication between the Contractor’s personnel at the job site and the batching plant during concrete placement.

## Concrete Temperature

### The permissible concrete temperature at the point of placement is as follows:

|  |  |
| --- | --- |
| **Thickness of Structure Section (m)** | **Permissible Concrete Temperature at the Point of Placement (°C)** |
| **Minimum** | **Maximum** |
| < 0.3 | 10 | 30 |
| 0.3 to ≤ 1 | 10 | 30 |

### Do not use concrete that fails to meet the permissible temperatures at the point of placement.

### To avoid cracking of the concrete due to sudden temperature change, do not remove weather protection measures until the concrete has cooled to the temperature differential specified in CAN/CSA-A23.1, Table 21.

## Hot Weather Requirements

### Hot weather requirements apply when the air temperature is at or above 25°C, or is forecast to rise to 25°C within 24 hours of placement.

### Protect formwork, reinforcement, and concrete equipment from the direct rays of the sun, or cool by fogging and evaporation. Dampen subgrade surfaces prior to concrete placement.

### Provide adequate personnel and equipment to transport, place, consolidate, and finish the concrete at the fastest possible rate. Obtain prior authorization from the Minister for the proposed equipment and procedures for hot weather concreting.

### Provide protection from drying in accordance with CAN/CSA-A23.1.

## Cold Weather Requirements

### Cold weather requirements apply when the air temperature is at or below 5°C, or is forecast to fall below 5°C within 24 hours of placing.

### When concrete is to be placed in cold weather, have all materials and equipment needed for adequate protection and curing on hand and ready for use before concrete placement is started. Obtain prior authorization from the Minister for the proposed enclosures, equipment, and procedures for cold weather concreting.

### Do not place concrete against any surface that has a temperature of less than 5°C. Remove all snow and ice. Preheat such surfaces for 24 hours or as required to obtain surface temperatures of 5°C minimum, whichever is longer, prior to placing concrete.

### Design and construct heating and hoarding protection measures including heated enclosures, coverings, insulation, or a suitable combination of these methods in accordance with CAN/CSA-A23.1.

### Inspect heating and hoarding measures at least every 4 hours and verify that enclosures, coverings, and insulation are in place, there is adequate heater fuel, and the specified temperatures are being maintained.

### Provide a sufficient number of adequately sized and properly vented heaters. Do not place heaters at locations that may cause rapid drying of freshly placed concrete. Use fans to constantly circulate warm air within the enclosure. Do not use tiger torches or other open flame burners as heaters.

## Placing of Concrete

### Place concrete in accordance with CAN/CSA-A23.1 unless specified otherwise.

### Do not schedule or place concrete during periods that have a high probability of rain or snow. Provide adequate materials on Site to protect concrete from the harmful effects of rain or snow during placement.

### Convey concrete from the point of supply to its final position as rapidly as practicable, by methods that will prevent segregation, loss of ingredients, or damage by exposure to the elements.

### Completely discharge and place concrete within the forms no later than 90 minutes after the cement has been mixed with the water or aggregates. Reduce the time between batching and complete discharge to 60 minutes when the ambient air temperature exceeds 25°C.

### Place the concrete in a continuous operation until the unit section is completed. Use a concrete placing rate that ensures that each layer is placed while the previous layer is soft or plastic; the two layers become monolithic by penetration of the vibrators; and cold joints are not produced.

### Do not place concrete faster than the rate for which the forms have been designed or at which the concrete can be properly consolidated. Regulate the deposition of concrete such that it is properly consolidated in horizontal layers 500 mm in thickness with minimum lateral movement.

### Use placing equipment of such size, design, and condition so as to steadily supply concrete at the point of placement. Provide equipment that has devices necessary to permit the prompt and complete discharge of concrete without segregation and with the required slump.

### Limit the unrestricted drop of concrete to less than 1.5 m. If the drop of concrete is in excess of 1.5 m, use chutes or trunks to prevent segregation of the materials.

### Maintain all placing equipment free from hardened concrete and foreign materials and clean such equipment at frequent intervals. Do not use conveying equipment made from aluminum alloys.

### If concrete is to be placed at night, supply a lighting system that will illuminate the inside of the forms, and provide a safe workplace.

### Do not perform concreting under water unless authorized by the Minister.

### Whenever concrete is being placed by pumping, provide a standby concrete pump unit or other appropriate placement equipment at the Site as authorized by the Minister.

## Consolidating Concrete

### Uniformly and thoroughly compact concrete as it is being placed. Use vibrators, of the proper size, frequency and amplitude, supplemented by hand spading and tamping when required, to secure a dense, homogeneous concrete, a good bond with the reinforcing steel and embedded items, and a smooth formed surface free of air pockets and surface blemishes.

### Do not use concrete vibrators for moving concrete laterally. Thoroughly and systematically vibrate concrete in the previously placed layer before placing the overlying layer.

### Operate vibrators in a vertical position and allow the vibrating head to penetrate the top portion of the underlying concrete at a uniform spacing over the entire area of placement. Maintain the distance between insertions at approximately 12 times the radius of action of the vibrator so that the area under vibration overlaps the just-vibrated area by several centimetres. Do not allow segregation of the ingredients or laitance to appear on the surface.

### Do not allow vibrators to disturb embedded parts.

### Provide spare vibrators at the point of placement to maintain production.

## Construction Joints

### Prepare construction joints to provide an adequate bond between successive and adjacent lifts of concrete. Roughen the construction joint interface to an amplitude of 5 mm. Use air-water cutting, sandblasting, high pressure water jets, or other authorized means to remove all laitance, unsound mortar, and inferior surface concrete, and to expose clean, sound, fine aggregate without undercutting the edges of coarse aggregate particles.

### Provide a clean concrete joint that is saturated surface dry at the time new concrete is placed on it.

### Dispose of wastewater employed in cutting, washing, and rinsing of concrete surfaces such that the wastewater does not stain, discolour, or affect exposed surfaces of the structures, or damage the environment.

## Concrete Finishing

### Provide a finished surface that is smooth, uniform in texture, and free from streaks, discoloration, or other imperfections.

### Surface Irregularities:

#### Local surface irregularities are classified as “abrupt” or “gradual.”

#### Abrupt irregularities mean offsets or fins caused by displaced or misplaced form sheeting, lining, or form sections or by defective form lumber, or improper screeding or trowelling.

#### Gradual irregularities mean bulges or depressions resulting in gradual changes in the concrete surface.

### Measuring Surface Irregularities:

#### Measure irregularities as deviations from a surface, with a 3 m long straightedge or shaped template authorized by the Minister. Move the position of the straightedge about the irregularity as necessary to locate the point where the maximum height and slope exists.

#### For irregularities protruding above the surface, place 1 end of the straightedge on top of the irregularity. The height of the irregularity is determined by measuring the existing gap that is perpendicular to the straightedge. The length of the irregularity is determined by measuring the distance along the straightedge from the gap to the point of contact at the top of the irregularity. The slope of the irregularity is the ratio of the height to length.

#### For irregularities extending below the surface, place the straightedge across the irregularity. The height of the irregularity is determined by measuring the gap between the straightedge and the surface. The length of the irregularity is the distance along the straightedge from the gap to the point of contact with the surface. The slope of the irregularity is the ratio of the height to length.

### Finishes for Formed Surfaces:

#### F1:

##### Applies to permanently concealed formed surfaces upon or against which fill or concrete is to be placed.

##### F1 surfaces require no treatment beyond the repair of defective concrete and dry packing of tie-rod holes. Cut back form ties to a minimum depth of 25 mm from the concrete surface.

#### F3:

##### Applies to permanently exposed formed surfaces and formed surfaces exposed to water.

##### Limit the height of abrupt irregularities to no more than [3 mm]. Limit the height of gradual irregularities to no more than 6 mm and the ratio of height to length to no steeper than [1:16].

##### Immediately after removing forms, repair surface irregularities, thoroughly expose voids and other holes by powered wire brushing, dry pack tie-rod holes and surface voids in excess of 10 mm diameter. Cut back form ties to a minimum depth of 25 mm from the concrete surface. Repair defective and damaged areas.

##### Provide a sacked-rubbed finish in accordance with CAN/CSA-A23.1.

#### [ ]

### Finishes for Unformed Surfaces:

#### U1:

##### Applies to permanently concealed unformed surfaces that will be covered by fill or concrete. It is also the first stage for a U3 finish.

##### Level and screed the concrete surface to produce a uniform surface.

#### U3:

##### Applies to permanently exposed unformed surfaces and unformed surfaces exposed to water.

##### Limit the height of abrupt irregularities to no more than [3 mm]. Limit the height of gradual irregularities to no more than [6 mm] and the ratio of height to length no steeper than [1:16.]

##### Level and screed the concrete surface followed by floating and applying a steel trowel finish to produce a dense uniform surface, free of blemishes, ripples, and trowel marks to the required lines, slopes, and elevations.

#### [ ]

## Curing and Protection

### Maintain all material and equipment required for curing and protection on hand at the Site prior to placing any concrete.

### Do not commence curing until after finishing.

### Commence curing of exposed surfaces as soon as the concrete has hardened sufficiently to prevent surface damage.

### Continuously moist cure all concrete for a minimum duration of 7 consecutive days at an ambient temperature maintained above 10°C.

### Continuously moist cure concrete by covering with absorptive mat or fabric kept wet by using a system of perforated pipes, mechanical sprinklers, porous hoses, or by other methods that keep all surfaces continuously wet. Initially cure formed surfaces by leaving forms in position and keeping such forms continuously wet.

### Do not use curing water that is more than 11°C cooler than the concrete temperature.

### Do not use curing compound [except on slabs as specified in the Contract Documents].

### If authorized by the Minister, apply curing compounds at a uniform rate by mechanical application methods. Provide complete coverage by applying 2 coats at right angles to each other. Minimum coverage is 0.20 L/m2. Apply curing compound immediately after finishing and as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the compound will be absorbed into the concrete.

## Repair of Concrete

### Examine all concrete surfaces and clearly mark out defective areas to be repaired. Obtain the Minister’s authorization of the delineated repair areas and the proposed method and equipment to be used for the repairs prior to commencing with the work.

### Completely remove all damaged, deteriorated, loosened, or unbonded concrete down to sound concrete. Remove microfractured surfaces resulting from the concrete removal process.

### Sawcut the perimeter of areas requiring concrete removal and replacement perpendicular to the surface to a minimum depth of 25 mm. Do not use any repair method that produces a featheredge.

### Prior to filling, provide a repair area that is clean and saturated surface dry except where the repair technique requires a dry surface.

### Use dry-pack mortar for filling holes left by the removal of form ties, for narrow grooves cut for repair of cracks, and for repair of small honeycombed areas where lateral restraint can be obtained. Pre-soak the repair area, allow the area to attain a saturated surface dry condition, and apply a cement paste bond coat prior to filling with mortar. Dry-pack mortar is to consist of 1 part Portland Cement to 2.5 parts sand, by mass.

### Mortar filling with a polymerized mortar placed under pressure by use of a mortar gun or head box may be used for repairing defects that are too wide for dry-pack filling, too shallow for concrete placement, and no deeper than the far side of the reinforcement that is nearest the surface. [Treat the surface of the concrete to be repaired with a compatible acrylic bonding agent as authorized by the Minister prior to mortar filling.]

### Completely remove honeycombed areas down to sound concrete or to the required depth behind the reinforcing steel, whichever is greater. The depth required beyond the reinforcing steel is 1.5 times the maximum aggregate size of the replacement concrete or 25 mm, whichever is greater. [Treat the surface of the concrete to be repaired with a high percentage solids epoxy bonding agent or acrylic bonding agent as authorized by the Minister prior to concrete replacement.] Construct the repair area slightly proud of the general surface and then grind it to match within the specified tolerances.

### Provide replacement concrete that has the same strength and durability characteristics as the adjacent specified concrete. Use cement that provides a finish colour that matches the surrounding concrete surfaces in areas that are permanently exposed.

### Following repairs, promptly initiate curing. Provide completed repair areas that are tightly bonded to the underlying concrete, and are free of shrinkage cracks or hollow void areas.

## Environmental Requirements

### Contain all wastewater including that from washing truck mixers, in settlement ponds. Do not release any water from the settlement ponds until it meets the Regulatory Requirements.

### Provide disposal bins at the Minister’s site laboratory for collecting waste concrete and other test materials. Empty the bins when required by the Minister.

### Place waste rejected concrete and waste materials from settling ponds in waste disposal areas on-Site as authorized by the Minister or off-Site waste disposal facilities.

**END OF SECTION**

**Concrete Pour Release Form - 03305.01**

Project Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Contract Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Submittal Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structure: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pour Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pour Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| **List of Work Items** | **Initial Completed and Checked** |
| **Contractor** | **Minister** |
| **Surface Preparation**• Construction Joint Preparation • Subgrade Preparation• Other |  |  |
| **Embedded Parts**• Reinforcing Steel• Embedded Parts• Waterstop• Other |  |  |
| **Curing and Protection**• Curing Requirements• Cold Weather Requirements• Hot Weather Requirements• Other |  |  |
| **Concrete Placement**• Conveying Equipment• Vibrators• Lighting• Equipment Access• Standby Equipment• Other |  |  |
| **Formwork**• Formwork• Shoring• Other |  |  |
| **Installation**• Lines• Elevations• Dimensions• Other |  |  |
| Submitted By: (Contractor) Date:Authorization to Order Concrete: (Minister) Date: |

# General

## References

### Provide roller compacted concrete (RCC) in accordance with the following standards (latest revision) except where specified otherwise.

### American Society for Testing and Materials (ASTM).

#### ASTM C94/C94M Standard Specification for Ready-Mixed Concrete.

#### ASTM C114 Standard Test Methods for Chemical Analysis of Hydraulic Cement.

#### ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.

#### ASTM C295 Standard Guide for Petrographic Examination of Aggregates for Concrete.

#### ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete.

#### ASTM C566 Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying.

#### ASTM C1040 Standard Test Methods for Density of Unhardened and Hardened Concrete in Place by Nuclear Methods.

#### ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

#### ASTM D2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (56,000 ft-lbf/ft3) (2,700 kN-m/m3).

#### ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

#### ASTM D4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

### Canadian Standards Association (CSA).

#### CAN/CSA-A3000 Cementitious Materials Compendium.

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CAN/CSA-A23.2 Methods of Test for Concrete.

## Submittals

### Provide the following submittals.

### Cementitious Materials:

#### Details of the source of cement and manufacturer’s recent test data including total alkali content expressed as Na2O equivalent, prior to constructing the test section.

#### Details of the source of the fly ash and manufacturer’s recent test data including gradation, loss on ignition, specific gravity, SiO2, Al2O3, Fe2O3 contents, and total alkali content expressed as Na2O equivalent prior to constructing the test section.

### Mix Design by the Contractor: RCC mix designs, including the results of the moisture density tests as specified in clause 1.3.3, immediately following satisfactory completion of the test section. [Bedding mortar mix design including the results of compressive strength tests at least 15 days prior to its use.] Have mix designs stamped by a specialist concrete materials engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

### RCC Test Section:

#### Test results for the proposed RCC mix design that will be used for constructing the test section at least 15 days prior to its use. Include proportions of all RCC mix ingredients, and the results of the moisture density and compressive strength tests.

#### Test results for the RCC mix used to construct the test section after the test section has been completed. Include proportions of all RCC mix ingredients, and the results of the moisture density tests after placement, and compressive strength tests.

### Aggregates:

#### The source of aggregates which will be used for the Works for the duration of the Contract within 30 days following the date of the Letter of Acceptance.

#### The results of the petrographic analysis, and the results of tests specified in clause 1.3.2 at least 30 days prior to delivering any aggregate to the Site.

#### The results of tests conducted during progress of the work within 24 hours after completion of the tests.

### Batch Plant:

#### A detail description of the RCC batch plant, including location, production capacity, aggregate feed equipment, water supply system, and pug mill mixers, at least 30 days prior to mobilizing the plant to the Site.

#### Certification by a CSA certified materials engineering and testing company that the batch plant equipment has been calibrated and meets the requirements of CAN/CSA-A23.1 clause 18, at least 15 days prior to any RCC batching operation.

#### Copy of batch records on a daily basis during batching operations.

### Hauling Equipment:

#### A description of the equipment proposed for transporting the RCC mixture from the batch plant to the placing equipment at least 30 days prior to constructing the test section.

### Placing Equipment:

#### A description of the equipment proposed for the laydown or placing of the RCC mixture, the method of control, and the manufacturer’s literature on the laydown machine (paver), at least 30 days prior to constructing the test section. Include the manufacturer’s written instructions on adjustments and operating procedures necessary to produce a tight, smooth surface on the RCC.

### Compaction Equipment:

#### A description of the rollers proposed for use, at least 30 days prior to constructing the test section. Include the manufacturer’s literature showing the frequency and amplitude of vibration, operating weight, drum dimensions, and kg/mm of the vibratory roller. Include documentation certifying that the frequency and amplitude requirements have been tested and met, within 4 months of date of commencing placement of RCC at the Site.

### RCC Placement:

#### Details of the procedures for hot and cold weather placing at least 15 days prior to placement of RCC.

#### A detailed plan of the proposed paving pattern at least 15 days prior to placement of RCC showing all planned construction joints, means to supply and control run-off of curing water, and protection methods to be used.

#### A schedule of placement operations at least 15 days prior to commencing placement of RCC. Update the schedule as required by the Minister.

#### Delivery tickets at the area of placement as soon as the batch is delivered.

## Quality Control

### Quality Control Program

#### Provide a quality control program to confirm that the specified requirements will be consistently attained through out the Work. Incorporate the specified testing, and any additional testing or measures required by the Contractor.

#### Provide experienced qualified supervisors to oversee quality control throughout the aggregate production, and batching, placement, compaction, curing, protection, and construction of RCC.

### Aggregate Tests by the Contractor:

#### Perform a petrographic analysis by an experienced qualified petrographer conducted in accordance with ASTM C295 and indicate the acceptability of the aggregate for use in the RCC specified in the Contract Documents prior to commencing the test section.

#### Perform tests of aggregates during production to confirm that the aggregates meet the specified requirements.

#### Conduct a minimum of one of each of the following tests prior to constructing the test section. Perform an additional set of each of the tests for every [5,000 m3] of RCC placed thereafter.

##### Sieve analysis: In accordance with CAN/CSA-A23.2–2A.

##### Clay lumps: In accordance with CAN/CSA-A23.2–3A.

##### Low-density materials: In accordance with CAN/CSA-A23.2–4A.

##### Materials finer than 80 μm: In accordance with CAN/CSA-A23.2–5A.

##### Relative density and absorption of fine aggregate: In accordance with CAN/CSA-A23.2–6A.

##### Organic impurities in fine aggregate: In accordance with CAN/CSA-A23.2–7A.

##### Soundness: In accordance with CAN/CSA-A23.2–9A.

##### Relative density and absorption of coarse aggregate: In accordance with CAN/CSA-A23.2–12A.

##### Resistance of degradation by abrasion and impact: In accordance with CAN/CSA-A23.2–16A and CAN/CSA-A23.2–17A.

#### At the beginning of each shift, or as otherwise required by the Minister, perform moisture tests on the coarse and fine aggregate in accordance with CAN/CSA-A23.2–11 and ASTM C566.

### Mix Design and Testing by the Contractor:

#### Engage an independent CSA certified materials engineering and testing company to select RCC mix proportions and conduct laboratory testing.

#### Proportion the RCC mix in accordance with [ACI \_\_\_\_\_\_, CSA \_\_\_\_.] Select proportions to provide the necessary placeability, density, strength, durability, and workability.

#### Conduct laboratory testing and construct the test section using mix ingredients obtained from the same source as proposed for the RCC production work.

#### Conduct tests of the RCC mix design that is proposed for use in constructing the test section including proportions of all RCC mix ingredients, and the results of the moisture density and compressive strength tests.

#### Conduct tests of the RCC mix that was used to construct the test section including proportions of all RCC mix ingredients, and the results of the moisture density and compressive strength tests.

#### The Minister will authorize RCC production based on the results of the moisture density tests conducted on the RCC used in test section. Notwithstanding the Minister’s authorization to proceed with RCC production, the Contractor is responsible for meeting all of the specified requirements.

### Test Section by the Contractor

#### Construct a test section at least [30.0] m long by [4.0] m wide by placing and compacting [3], [300] mm thick lifts, at a location determined by the Minister, at least [10] days prior to the start of RCC production. A minimum of [2] separate days will be required for the construction of the test section.

#### Notify the Minister at least 5 days prior to starting construction of the test section.

#### Involve key supervisory and operating personnel to be employed on the RCC production work in the construction of the test section.

#### Use the same equipment, materials, and construction techniques as for the RCC production work.

#### Demonstrate the proposed method of batching, mixing, hauling, placing, spreading, compacting, and curing of the RCC. Additionally, demonstrate the rolling pattern, joint preparation, lift surface cleaning, and the forming of the downstream facing.

#### Form the ends and sides of the test section and compact the RCC adjacent to the forms using the same methods as for the RCC production work.

#### Prior to commencing the test section, calibrate the batch plant. Perform uniformity tests on samples from the test section.

#### Construct additional test sections if the initial test section does not produce RCC that meets the specified requirements.

#### Provide [4], 150 mm diameter full depth cores of RCC from selected areas of each lift, 7 days after completion of the test section.

### Calibration Block

#### During construction of the test section, fabricate a calibration block for the nuclear density gauge at the location authorized by the Minister. The RCC block is to be 450 mm by 450 mm and at least 50 mm thicker than the specified lift thickness, and be compacted to at least 98% of the target density. Alternatively, the Contractor may use structural concrete to fabricate the calibration block. Measure and weigh the block to determine the actual density. The block will be used to check the calibration of the nuclear density gauge. Drill a hole in the block to a depth equivalent to the specified lift thickness to accommodate the nuclear gauge probe.

### Record the following information on the delivery tickets of each batch of RCC.

#### Slip serial number and date.

#### Cement type and actual batch weights of each mix ingredient.

#### Time of loading or first mixing of cement, fly ash, and aggregates.

#### Time when the load arrived at the placement point.

#### Time when the discharge of the load was started.

#### Time when the discharge of load was completed.

#### RCC temperature during placing.

## Quality Assurance

### Sampling and Testing by the Minister:

#### Provide the Minister with access to aggregate source and stockpiles, batch plant, and placement locations for the purpose of sampling and inspecting materials.

#### At the batch plant, provide suitable facilities including platforms, tools, and equipment to permit samples of materials to be readily obtained by the Minister from each of the batchers. Temporarily stop batching to allow for sampling.

### Aggregate Tests by the Minister:

#### The Minister may sample the aggregates. Tests may include moisture content, absorption, grain size, organic content colour test, or other tests as required.

#### The Minister will conduct inspections of aggregate stockpiles to check for segregation and contamination. Reprocess or remove any material that, in the opinion of the Minister, is unacceptable.

### Density Tests by the Minister:

#### Moisture density tests will be conducted on the initial mixed batches of RCC in accordance with ASTM D1557, and the maximum wet density of the concrete will be determined by the Minister. The resulting maximum wet density will be used as the “target density.” The “target density” will be checked on a regular basis during progress of the Work.

#### Field density tests will be conducted in accordance with ASTM C1040, within 30 minutes after completion of vibratory rolling. The moisture content will be determined in accordance with ASTM D3017.

#### Three, full depth nuclear density gauge tests of the calibration block in the direct transmission mode will be performed by the Minister, and the results averaged. The average nuclear density gauge reading will be compared with the measured unit weight of the block, and the difference used as a correction factor for all readings taken that day.

### Uniformity Tests by the Minister:

#### Uniformity Requirements:

|  |  |  |
| --- | --- | --- |
| **Test** | **Allowable Max. Difference** | **Standard** |
| Water content (% by mass) | 15% | ASTM D2216 |
| Coarse aggregate content (% by mass) | 15% | ASTM C94/C94M |
| Unit weight of air–free mortar (kg/m3) | 2% | ASTM C94/C94M |
| Air content | 100% | CAN/CSA-A23.2–4C |
| Wet density | 2% | CAN/CSA-A23.2–6C |

#### Samples for the uniformity test will be taken from the placement area following spreading of the material.

#### One uniformity test will consist of the results of testing 3 samples taken at intervals of every 15 m3 of RCC that has been produced.

#### The allowable maximum difference equals the maximum value minus the minimum value, divided by the average of the 3 tests.

### Compressive Strength Tests by the Minister:

#### In conjunction with the density tests, compressive strength tests will be conducted on the initial mixed batches of RCC after placement. Provide the Minister with a total of [ ], 150 mm diameter full depth cores of RCC from selected areas of the lift.

#### One RCC compressive strength test will consist of testing 2 cylinders at 28 days after placement.

#### RCC compressive strength test results will be evaluated in accordance with CSA-A23.1.

#### Compressive strength testing of bedding mortar will be conducted in accordance with CSA-A23.2-1B.

### If RCC [or bedding mortar] placed in the Work fails to meet the specified requirements, the Minister may order that 1 or more of the following courses of action be carried out:

#### The mix is redesigned.

#### Full depth cores are drilled, from the portions of the structure in question, and tested in accordance with CSA-A23.2–14C.

#### Defective materials are removed and replaced.

### Temperature Measurements by the Minister: By placing a thermometer in the RCC delivered to the placement area.

# Products

## Materials

### Provide materials in accordance with the following.

### Cement: Type 50, Sulphate Resistant Portland Cement, in accordance with CAN/CSA-A3000 with a total alkali content (as Na2O equivalent) less than 0.65%. Provide cement from the same manufacturing source throughout the Contract for consistent quality and compatibility with all RCC materials.

### Fly Ash: Class CI or F fly ash in accordance with CAN/CSA-A3000, with a total alkali content less than [3]% (Na2O equivalent) and an oxide (CaO) content less than [8]%. Determine the total alkali content and water-soluble alkali content, expressed as Na2O equivalent, in accordance with ASTM C114. Provide fly ash from the same manufacturing source throughout the Contract for consistent quality and compatibility with all RCC materials.

### Admixtures:

#### From the same manufacturer for compatibility. Provide liquid type admixtures. Provide type WN water reducing agent when required.

#### Chemical admixtures: In accordance with ASTM C494/C494M.

#### Do not use calcium chloride or any admixture formulated with calcium chloride.

### Water: Clean and free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis, and other deleterious substances, and in accordance with CAN/CSA-A23.1. Obtain permits as required to use water from natural sources.

### Fine Aggregates:

#### In accordance with CAN/CSA‑A23.1, clause 5 and Table 6, consisting of clean, hard, dense, durable, uncoated rock fragments.

#### [With a plasticity index less than [5], and the following gradation:

|  |  |
| --- | --- |
| **Sieve Size** | **Percent Passing by Mass** |
| 10 mm | 100 |
| 4.75 mm | 85-100 |
| 1.25 mm | 45-65 |
| 600 μm | 35-50 |
| 150 μm | 10-25 |
| 75 μm | 5-10] |

####  [Gradation FA1 as specified in CAN/CSA-A23.1, Table 4.]

#### Fineness modulus to be between [ ] and [ ] and not more than +/-0.20 from the value used in the accepted mix design.

### Coarse Aggregates:

#### In accordance with CAN/CSA-A23.1, clause 5 and Table 6 Class F–1 exposure conditions, consisting of natural gravel, crushed rock, or a combination of both, and be clean, hard, dense, durable, uncoated rock fragments.

#### Nominal size of [40-5] in accordance with CAN/CSA-A23.1, Table 5, Group 1. [Blend the 40–20 material from Group II and the 20–5 material from Group I to achieve the specified gradation].

#### At least 50% by mass of the aggregate portion larger than 10 mm to have 2 or more fractured faces.

#### Wash coarse aggregates during processing and stockpile separately at the batch plant stockpile areas.

## Mixes

### Provide RCC in accordance with the following:

#### Total cementitious content (cement and fly ash) of at least [180 kg/m3].  Minimum fly ash content, by mass of cementitious materials, of 25%.

#### Minimum compressive strength of [28] MPa at 28 days.

#### Maximum water/cementitious materials ratio of [ ].

#### Maximum wet density: In accordance with ASTM D1557.

### Bedding Mortar: Sand/cement mortar with a minimum compressive strength of [30 MPa] at 28 days, and a slump between 180 mm and 230 mm. Incorporate a water-reducing admixture and a retarding admixture as required.

### Structural Concrete: Refer to Section [ ] – Cast-in-Place Concrete.

## Contraction Joints

### [ ].

# Execution

## Aggregates

### Stockpiling and Handling:

#### Fine and coarse aggregates stockpiling operations are subject to inspection and authorization by the Minister.

#### Strip topsoil and undesirable overburden material in the aggregate stockpile areas. Where stripping fails to expose a suitable granular material for the stockpile base, grade the area to form a 2% slope, and place granular material to a thickness of 300 mm. Provide surface drainage to prevent any accumulation of water in the area.

#### Use stockpiling methods that minimize segregation, aggregate breakage, and contamination.

#### To reduce segregation, separately stockpile coarse aggregates into several size fractions and batch these fractions separately. Aggregates may be preblended in a separate aggregate feed system which discharges directly into the batch plant.

#### Maintain a minimum separation distance of 10 m between stockpiles in order to prevent the intermixing of different aggregate sizes. Provide additional measures as authorized by the Minister to prevent separation of fine aggregates due to wind, and to prevent contamination with blow dirt.

#### Remove and transfer fine and coarse aggregates from the stockpiles to the batching or conveying equipment by front-end loader machines, power shovels, or similar equipment. Provide a backup loading unit at the plant in the event of breakdown of the primary unit. Do not use crawler or pneumatic–tired equipment for pushing coarse aggregate off the stockpiles to the conveying equipment.

#### Do not commence production and placement of RCC until at least 50% of the required fine and coarse aggregates have been stockpiled at the batch plant.

### Moisture Content:

#### Provide adequate drainage time prior to transferring aggregates into the batch plant bins.

#### Maintain the moisture content of the batched aggregates within a range of 1% during any 1 hour of continuous plant operation. The maximum moisture content of aggregates delivered to the batch plant stockpiles cannot exceed 6% (based on saturated surface dry weights) for fine aggregates and 3% for coarse aggregates.

## RCC Production

### Provide a batch plant located on Site and no more than 15 minutes haul time from the placement area. The plant may be either weigh-batch type or continuous type with a minimum capacity of [200 t/h].

### Provide separate weigh hoppers for cementitious material and aggregate.

### Provide plant storage facilities consisting of a minimum of 5 storage bins (1 cement, 1 fly ash, 1 fine aggregate, 2 coarse aggregate). Provide bins with sufficient capacity to continuously supply the mixer operating at full capacity. A single coarse aggregate bin is acceptable, provided that the aggregates are preblended in a separate aggregate feed system which discharges directly into the batch plant. A single bin for both the cement and fly ash is acceptable, provided that the cement and fly ash are preblended at the cement plant, and mill test certificates certifying that the correct proportions are submitted. Submit mill test certificates for each 100 tonnes of cementitious material produced, no later than 30 days after the batch plant has been mobilized to the Site.

### Verify that the accuracy of weigh scales conforms to the tolerances specified in CAN/CSA-A23.1.

### Provide for rapid adjustment for effecting changes in the RCC mix proportions and to compensate for variations in the amounts of moisture in the aggregates.

### Equip the fine aggregate bin with a moisture indicator, and make moisture adjustments based on the moisture indicator reading.

### Record and print the target weights and actual weights of all batched materials.

### Adjust coarse and fine aggregate batches for undersize and oversize aggregate within each aggregate class.

### Measure water by weight or by an in-line flow meter. Provide a control valve for the water capable of gradual adjustment during the mixing process to compensate for varying moisture content in the aggregates, which is automatically controlled, and able to be closed if cement fly ash or aggregate does not enter the mixer at the required rate.

## Mixing and Transporting RCC

### Mixing:

#### Provide a stationary mixer of the twin-shaft pug-mill type that is capable of producing a uniform mixture with a discharge hopper having a capacity of at least 1 m3. Do not use drum mixers or transit mixers for mixing batches.

#### Provide positive means for controlling and adjusting the mixing time, maintaining a constant time of mixing and maintaining constant speed of pug-mill shafts.

#### The minimum mixing time for continuous mixing pug-mills or batch type pug‑mills is 10 seconds.

#### Waste the initial 2 m3 of mix produced by a continuous mix pug-mill at the start of production or after a shutdown, unless the plant has the capability of simultaneously stopping and starting the flow of materials into the mixing chamber.

#### Maintain the same flow of cement and fly ash from the silo to the feeder for all levels of material in each silo.

#### Maintain the shaft speed of the pug-mill at the speed recommended by the manufacturer.

#### Operate the pug-mills at or near their rated capacity.

#### Do not extend the RCC mill above the tops of the paddles of the pug-mill mixer when the paddles are in the vertical position.

#### Keep the mixer and mixer paddle surfaces free of hardened concrete and other contamination.

#### Replace mixer paddles worn down by more than 10% of new paddles with the same type and manufacture.

#### Proportion RCC discharged from the mixing plant within the following tolerances from the design mix settings.

#### Cement +/-2%

#### Fly ash +/-2%

#### Water +/-3%

#### Aggregate +/-3%

#### Admixture +/-3%

### Uniformity Requirements:

#### Provide pug-mill mixers capable of producing RCC that is thoroughly and uniformly mixed and of discharging the RCC to meet the specified uniformity requirements.

#### If the mixing plant fails to satisfy the specified uniformity requirements, increase the mixing time or modify the plant.

#### Do not resume RCC production until the specified uniformity requirements are achieved.

### Transporting:

#### Provide delivery equipment compatible with the capacities of the mixing plant and the spreading and compaction equipment.

#### Provide mobile belt conveyors, end dump haul vehicles with special drop control tailgates, or other equipment that can place the RCC mix without excessive segregation.

#### Do not haul over freshly placed RCC, except as authorized by the Minister.

#### Maintain haul vehicles free of deleterious materials including oil, grease, dry RCC, soil, and mud.

#### Do not drop RCC more than 1.8 m.

#### Operate haul vehicles in a manner that precludes tight turns, sudden stops, or other procedures that can damage previously placed RCC.

## RCC Temperature

### The maximum permissible temperature of the RCC at the point of placement is 27°C, and the minimum permissible temperature is 10°C.

### Pre-cooling measures may be required to achieve the maximum permissible RCC temperature and may include one or more of the following:

#### Introduction of chilled water into the mix.

#### Cooling coarse aggregate with chilled water using sprinklers or fog spray.

#### Shading aggregate stockpiles and bins.

#### Injecting the mix with liquid nitrogen or other authorized methods.

#### Placing at night.

### Heat the mixing water and/or aggregates as required to produce RCC at the specified minimum temperature of 10°C.

## Hot Weather Requirements

### Suspend RCC placement when the temperature of the RCC measured at the point of placement exceeds 27°C or, if a combination of high ambient temperature, solar heating, and wind dries the uncompacted RCC, preventing proper placement and compaction.

### Take the following precautions during periods of hot weather when the maximum daily air temperature is forecast to exceed 25°C:

#### Limit the time between placing succeeding lifts or exposure of a lift of RCC to a maximum of 45 minutes.

#### Sprinkle the underlying subgrade material with water immediately before placing RCC.

#### Keep the finished surfaces of newly laid RCC damp by applying a mist using spraying equipment authorized by the Minister.

#### Commence compaction once the spreading equipment is ahead of the compaction equipment by 10 m and no more than 20 m, and be complete within 30 minutes from the start of batching the RCC.

### If heat or wind results in excessive drying of the RCC, utilize additional measures such as wind screens, mist or fog sprays applied immediately behind the placed RCC.

### If the hot weather precautions do not result in satisfactory placement conditions as determined by the Minister, suspend placement of the RCC.

## Cold Temperature Requirements

### Discontinue placement of RCC when the ambient air temperature reaches 5°C and is falling, and do not resume until the ambient temperature reaches 2°C and is rising.

### Do not place RCC on any surface containing frost, frozen material, or with a surface temperature less than 2°C.

## Placing, Spreading, and Compaction

### Place RCC across the full width of the specified cross section, and in lifts not exceeding [300] mm in thickness, after compaction.

### Do not expose more than 2 lift surfaces at any one time.

### Place RCC using tracked dozers or pavers.

### Maintain lift grade control using laser controlled equipment, grade stakes, or other suitable survey methods.

### Place and spread RCC in unsegregated layers.

### Do not operate tracked spreading equipment on compacted RCC surfaces.

### Maintain all equipment in good operating condition such that it does not leak oil, grease, or other fluids onto the RCC.

### Unless otherwise specified, begin compaction once the spreading equipment is ahead of the placing equipment by at least 10 m and no more than 20 m, and compaction is completed within 45 minutes from the start of batching.

### Compact the RCC using self-propelled, double steel drum vibratory rollers having an average mass per drum of at least 2.7 kg/mm of drum and a vibrating frequency of at least 1,500 cycles/minute.

### Provide a backup compactor at the placement area in the event of a breakdown of the primary unit.

### Keep surfaces of all compaction drums/wheels clean at all times.

### Do not operate compaction equipment in the vibratory mode when stationary.

### Compact RCC adjacent to [exterior facings], or other areas that are inaccessible to the larger compaction equipment using small vibratory rollers or plate tampers with a minimum mass of 100 kg.

### Do not operate the compaction equipment at speeds exceeding 2.5 km/h and do not displace the RCC.

### Provide a minimum of [4] passes of the specified compaction equipment for each lift where 1 pass means 1 trip across a point with both drums.

### Compact RCC lifts to a minimum of 98% of the target density, and to 96% of the target density adjacent to construction joints and formed surfaces (downstream vertical steps).

### Re-compact areas of incomplete compaction within the specified time limit.

### RCC lifts that have been compacted to less than 98% of the target density will be accepted provided that the moving average of 5 consecutive field density results are not less than 98% of the target density, with no individual test result less than 96% of the target density.

## Surface Preparation

### Prior to placing RCC, clean existing RCC surfaces with compressed air/water to expose but not undercut the aggregate, and to remove laitance and any loose material or contaminants.

### Cure and protect lift surfaces as specified in clause 3.13. Remove and replace surfaces that have dried.

### Provide and evenly spread a minimum 10 mm thick layer of bedding mortar on the lift surfaces [as specified in the Contract Documents]. Do not allow mortar to dry out. Cover with the overlying lift of RCC within 45 minutes of placing the bedding mortar. If the mortar has dried or suffers any degradation that can affect its strength properties, as determined by the Minister, remove the mortar, clean the lift surface, and reapply.

## Construction Joints

### Provide construction joints at locations specified in the Contract Documents or where the placement of RCC has been suspended due to the end of a work period or for other reasons.

### In the areas of the construction joint, form a ramp of 3H:1V or flatter slope by passing over the end of the freshly placed RCC with the compactor.

### Prepare the joint surfaces as specified in clause 3.8, prior to placing fresh RCC.

## Contraction Joints

### Provide contraction joints at the locations specified in the Contract Documents.

### [ ].

## Facing Formwork

### Form the exterior faces of the RCC to provide a finished surface that is within +/-50 mm of the specified lines, slopes, grades, and elevations specified in the Contract Documents.

### Provide and construct forms having sufficient stability and strength to withstand movement and pressures resulting from placement and compaction of the RCC. Provide temporary bracing, anchors, and other support as required.

### Prior to commencing RCC placement, erect formwork including supports to provide uninterrupted placement of RCC.

## Drainpipes

### Install drainpipes in slots cut into the RCC to the lines, grades, slopes, and elevations specified in the Contract Documents.

### Anchor drain pipes to prevent floatation and displacement during encasement with [bedding mortar] [cast-in-place concrete].

### Completely fill under the haunches and around the drainpipe with [bedding mortar] [cast-in-place concrete] as specified in the Contract Documents.

## Curing and Protection

### Do not use membrane curing compounds or polyethylene type sheets for curing RCC.

### Wet cure RCC lifts immediately after compaction has been completed, and keep continuously wet for a period of 7 consecutive days at a temperature above 5°C, or until immediately before placement of the subsequent lift begins. Remove and replace RCC surfaces that were not wet cured as specified.

### Provide wet curing by a fine mist water spray sprinkler system and/or wet burlap or wet geotextile covering all surfaces of the RCC lift.

### Burlap or geotextile covering is to consist of 2 or more layers and be properly weighted to prevent displacement in the wind. Thoroughly wet the coverings before placing, and keep continuously wet and in intimate contact with the surface and edges of the RCC during the entire curing period.

### Do not schedule or commence RCC placement during periods where the weather forecast includes a high probability of rain. Provide adequate quantities of plastic sheeting and other materials on Site to protect RCC from the harmful effects of rain.

### If rainfall occurs or is forecast to occur, cover all RCC lifts that are less than 12 hours old with plastic sheeting in accordance with ASTM C171.

### Immediately suspend RCC placement during heavy rains. If intermittent light rainfall occurs during RCC placement, suspend placement when free water begins to accumulate on the compacted surface; contamination of the RCC, vehicles, and equipment with deleterious materials occurs; or if the rain is adversely affecting any aspect of the RCC quality in the opinion of the Minister.

### Do not permit traffic or equipment on the RCC surface that causes any damage to the surface.

## Repair of RCC

### Remove and replace RCC that does not meet the specified requirements.

### Examine RCC surfaces and clearly mark out defective areas to be repaired. Obtain the Minister’s acceptance of the delineated areas prior to commencing the repairs.

### Do not use surface patching or coating procedures and materials to correct defective RCC areas.

### Remove defective RCC by cutting holes the full lift thickness so that the sides are perpendicular and parallel to the joint pattern and the edges are vertical. Fill the holes with structural concrete or RCC.

### If the RCC surface has not been wet cured as specified or has surface damage, remove the affected RCC to a minimum depth of 150 mm, and replace with structural concrete or RCC. Surface damage is any damage that would preclude adequate bonding to a subsequent lift of RCC as determined by the Minister.

### Following repairs, promptly initiate curing and protection measures.

## Environmental Requirements

### Provide dust collecting devices on cement and fly ash silos.

### Contain all wastewater including that from washing hauling equipment, in settlement ponds. Do not release any water from the settlement ponds until it meets the Regulatory Requirements authorities.

### Provide disposal bins at the Minister’s site laboratory for collecting waste concrete and other test materials. Empty the bins when required by the Minister.

### Place rejected RCC and waste materials from settling ponds in waste disposal areas on-Site as authorized by the Minister or off-Site waste disposal facilities.

**END OF SECTION**

# General

## Definitions

### “Blowpipe” means an air/water jet operated during shotcrete placement to assist in keeping Rebound and Overspray out of the work.

### “Dry Process Shotcrete” means a process where most of the water added to the shotcrete mixture is added at the nozzle.

### “Overspray” means shotcrete material deposited away from the intended receiving surface.

### “Pot (sometimes called Gun)” means a machine used to meter the shotcrete into the hose.

### “Pre-dampener” means a device used to mix a portion of the mixing water with the shotcrete. It can also be used to mix accelerator with shotcrete.

### “Rebound” means the material that bounces off the surface being shotcreted. It consists primarily of coarse particles and contains a lower proportion of cement than shotcrete mix.

### “Saturated Surface Dry” means the state of a material in which it will neither add nor subtract moisture from other material placed in contact with it.

### “Slake” means a process of deterioration of freshly exposed rock due to exposure to the atmosphere and/or water.

### “Sloughing” means the subsidence of shotcrete, due generally to excessive water in the mix or placing too great a thickness of shotcrete in a single pass.

### “Weep Drains” means pipes inserted in water–bearing fissures to relieve water pressure from behind the shotcrete.

### “Wet Process Shotcrete” means shotcrete in which all of the ingredients are mixed before introduction into the delivery hose. Compressed air is introduced at the material flow at the nozzle. If an accelerator is used, it is normally added at the nozzle.

## References

### Provide shotcrete in accordance with the following standards (latest revision) except where specified otherwise.

### American Concrete Institute (ACI).

#### ACI 506R Guide to Shotcrete.

#### ACI 506.2 Specifications for Materials, Proportioning and Application of Shotcrete.

#### ACI 506.3 Guide to Certification of Shotcrete Nozzlemen.

### American Society for Testing and Materials (ASTM).

#### ASTM A615/615M Standard Specification for Deformed and Plain Billet- Steel Bars for Concrete Reinforcement.

#### ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete.

#### ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete.

#### ASTM C642 Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.

#### ASTM C928 Standard Specification for Packaged, Dry, Rapid- Hardening Cementitious Materials for Concrete Repairs.

#### ASTM C1018 Standard Test Method for Flexural Toughness and First-Crack Strength of Fibre-Reinforced Concrete (Using Beam with Third-Point Loading).

#### ASTM C1116 Standard Specification for Fibre-Reinforced Concrete and Shotcrete.

#### ASTM C1117 Standard Test Method for Time of Setting of Shotcrete Mixtures by Penetration Resistance.

#### ASTM C1140 Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels.

### Canadian Standards Association (CSA).

#### CAN/CSA-A3000 Cementitious Materials Compendium.

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CAN/CSA-A23.2 Methods of Test for Concrete.

#### CSA-B137 SERIES Thermoplastic Pressure Piping Compendium.

#### CAN/CSA-G30.18 Billet-Steel Bars for Concrete Reinforcement.

#### CSA-G40.21 Structural Quality Steel.

## Submittals

### Provide the following submittals.

### Cementitious materials: Details of the source of cement, fly ash, silica fume, and admixtures including supplier’s test data at least 30 days prior to commencing shotcrete operations.

### Shotcrete [and grout] mix designs by the Contractor: Shotcrete [and grout ] mix designs at least 30 days prior to commencing shotcrete operations. Include the following in the mix design submittal:

#### Mix design number.

#### Shotcrete batch quantities in kg/m3 based on aggregates in a Saturated Surface Dry moisture state for Wet Process Shotcrete, and ready-mix supplied for Dry Process Shotcrete. Batch quantities for dry bagged supply are to be based on the mass of aggregates in a dry state.

#### Stamp of a specialist concrete materials engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

### Shotcreting plant: Details of the type, manufacturer’s name, model, and condition of the plant being proposed for the shotcrete, and details of other equipment required including the minimum operating air pressure, at least 15 days before the shotcreting plant is mobilized to the Site.

### Curing and protection: Details of the curing and protection procedures at least 10 days prior to commencing shotcrete operations.

## Quality Control

### Quality Control Program:

#### Provide a quality control program to ensure that the specified requirements will be consistently attained through out the Work. Incorporate the specified testing, and any additional testing or measures as required by the Contractor.

#### Provide experienced supervisors, operators, and nozzlemen qualified to perform the work in accordance with ACI 506.3R.

### Mix Designs by the Contractor:

#### Engage an independent CSA certified materials engineering and testing company to select shotcrete mix proportions. Select proportions to provide the necessary placeability, density, strength, and durability.

### Pre-Construction Test Panels and Cores:

#### In the presence of the Minister, and at least 20 days prior to application of shotcrete, produce test panels in accordance with ASTM C1140, [except provide panels that have a minimum base dimension of 500 mm by 500 mm and a minimum depth of 125 mm]. Construct test panel moulds of wood and sealed plywood, with 45° sloped sides to permit escape of Rebound. Construct test panels using the same nozzle and length of hose as the production shotcrete. [Do not use reinforcement or embedments, other than fibre reinforcement, in test panels.]

#### Provide 1 separate test panel sprayed for each trial mix design submitted and for each shooting position to be encountered in the Work.

#### Provide 3 core samples, 75 mm in diameter, from the panel for compressive strength tests.

#### Make 1 additional panel for each trial mix design for flexural strength and toughness testing.

#### Clearly mark each panel and core with a unique test number and the date cast, and deliver the samples to the Minister’s Site laboratory.

### Field Quality Control:

#### For the Wet Process Shotcrete, conduct as-placed air content and slump tests at discharge into the pump tests for each batch of shotcrete or as directed by the Minister.

#### Monitor and control the thickness of the shotcrete being applied by measuring the thickness at 1000 mm centres or closer using depth gauges or probes.

#### Provide 3 cores of suitable diameter and length for compressive strength tests for each day in which shotcrete is placed or for every [200] m2 of shotcrete placed, whichever results in more cores, and deliver them to the Minister’s Site laboratory.

#### Cast 1 test panel on each day shotcrete is placed or for every [200] m2 of shotcrete placed, whichever results in more panels. Cast the test panels at the times chosen by the Minister. Field cure test panels in the forms, in the same manner as the production shotcrete, for a minimum period of 48 hours, then transport the test panels in their forms and in a moist condition to the Minister’s Site laboratory.

#### Determine the air content from shotcrete sprayed into an air pressure meter base or from freshly applied material removed from in place and consolidated into the air meter base by rodding.

#### Determine the slump before fibre reinforcement and superplasticizer is added, and after the air entrainment agent is added.

### Anchor Proof Load Testing:

#### Conduct proof load tests on selected threadbar anchors in the presence of the Minister. Perform at least 1 load test for every [10] anchors installed or at more frequent intervals if anchors fail the load test.

#### Incrementally load the anchor to 0.10D, 0.25D, 0.50D, 0.75D, 1.00D, and 1.25D. Hold the maximum test load of 1.25D for a minimum of 10 minutes. The anchor design load (D) is [ ] kN.

#### Replace and retest any threadbar anchor that fails the proof load test.

## Quality Assurance

### The Minister will carry out the following tests on shotcrete:

#### Compressive strength on the core samples obtained from the test panels and the production shotcrete in accordance with CAN/CSA-A23.2.

#### Flexural strength and toughness indices on the test panels made from the trial mixes and the production shotcrete in accordance with ASTM C1018.

#### Boiled absorption and permeable voids on the core samples obtained from the test panels and the production shotcrete in accordance with ASTM C642.

#### Test results will be considered acceptable if the average of 3 specimens tested meets or exceeds the specified requirements. The test results for an individual specimen are to be greater than 80% of the specified compressive strength and toughness indices, and not more than 120% of the specified boiled absorption and permeable voids requirements.

### The Minister will carry out tests on the grout in accordance with CSA-A23.2-1B.

## Delivery, Storage, and Handling

### Store and handle products in a manner that prevents damage, deterioration, or contamination.

### Store cementitious materials and admixtures indoors. To prevent undue aging, use cementitious materials in the chronological order in which it was delivered to the Site.

# Products

## Materials

### Provide materials in accordance with the following.

### Cement: Type 50 Sulphate Resistant Portland Cement in accordance with CAN/CSA-A3000. Provide cement from the same manufacturing source throughout the Contract.

### Silica fume: Type U silica fume in accordance with CAN/CSA-A3000, with a minimum Si02 content of 90% by mass and a maximum carbon content of 5% by mass. Provide silica fume from the same manufacturing source throughout the Contract.

### Fly ash: Type F fly ash in accordance with CAN/CSA-A3000. Provide fly ash from the same manufacturing source throughout the Contract.

### Admixtures:

#### From the same manufacturer to ensure compatibility between air‑entraining agent, water reducing agent, and superplasticizing and set retarding admixtures. Conduct tests and trial mixes to verify that the admixtures are compatible with the mix ingredients.

#### Air-entraining admixture in accordance with ASTM C260.

#### Chemical admixture in accordance with ASTM C494/C494M.

#### Do not use calcium chloride or any admixture formulated with calcium or chloride.

#### Accelerating admixtures with prior authorization from the Minister:

##### To have a demonstrated ability, when used at the required proportions, to produce accelerated shotcrete meeting the specified requirements.

##### For Wet Process Shotcrete, dispense in liquid form at the nozzle in closely controlled quantities. For Dry Process Shotcrete, dispense in liquid form at the nozzle in closely controlled quantities or powdered accelerator either integrally mixed in the case of dry bagged material, or mechanically proportioned through the Pre-dampener in the case of ready-mix supply. Accelerators are not to be metered directly into the Pot.

### Water: Clean and free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis, and other deleterious substances and in accordance with CAN/CSA-A23.1. Obtain permits as required to use water from natural sources.

### Aggregate:

#### In accordance with CAN/CSA-A23.1, clause 5, consisting of clean, hard, dense, durable, uncoated rock fragments obtained by crushing, screening, washing, classifying, and blending.

#### Combined aggregate with the following gradation:

|  |  |
| --- | --- |
| **Metric Sieve Size(mm)** | **Total Passing Each Sieve Size% by Mass** |
| 14 | 100 |
| 10 | 90–100 |
| 5 | 70–85 |
| 2.5 | 50–70 |
| 1.25 | 35–55 |
| 0.630 | 20–35 |
| 0.315 | 8–20 |
| 0.160 | 2–10 |

### Shotcrete reinforcement: [50] mm long steel fibres in accordance with ASTM C1116 Type 1 with a minimum tensile strength of 820 MPa.

## Shotcrete Mix

### Provide shotcrete in accordance with the following:

|  |  |  |  |
| --- | --- | --- | --- |
| **Property** | **Age (Days)** | **Requirement** | **Test Method** |
| .1 Maximum W/C Ratio | — | 0.40 | — |
| .2 Air Content | — | 5% +/- 1.5% | CAN/CSA-A23.2–4C |
| .3 Slump | — | 60 mm +/-20 mm | CAN/CSA-A23.2–5C |
| .4 Minimum CompressiveStrength | 728 | 30 MPa40 MPa | CAN/CSA-A23.2–14C |
| .5 Minimum Toughness Indices I5 I10 | 77 | 3.55.0 | ASTM C1018ASTM C1018 |
| .6 Flexural Strength | 7 | 3 MPa | ASTM C1018 |
| .7 Maximum Boiled Absorption | 7 | 8% | ASTM C642 |
| .8 Maximum Volume of Permeable Voids | 7 | 17% | ASTM C642 |

 Note: Properties .1, .2, and .3 above apply to the Wet Process Shotcrete only.

### Design the shotcrete mix with a total cementitious (cement, silica fume, and fly ash) content that is not less than 20% by mass of the total ingredients.

### Provide a minimum of [60 kg] of steel fibres per cubic meter of shotcrete.

## Weep Drains

### Weep Drains: Schedule 40 PVC pipe in accordance with CSA-B137 Series. Shop cut [0.25 mm wide slots to provide an area of 2400 mm2/m] of pipe length as specified in the Contract Documents.

## Shotcrete Anchors

### Threadbar anchors: Reinforcing steel threadbars in accordance with ASTM A615/A615M, Grade 400. Provide hex nuts capable of developing 100% of the threadbar ultimate strength.

### Shotcrete anchors: Fabricate “bow tie” shotcrete anchors with reinforcing bars in accordance with CAN/CSA-G30.18, Grade 300, and plates in accordance with CSA-G40.21, Grade 300 W.

### Grout: [Cement grout with a maximum water/cement ratio of 0.40, and a minimum compressive strength of 30 MPa at 7 days.]

# Execution

## Batching, Mixing, and Conveyance

### Use air free of oil for applying shotcrete.

### Provide a separate air hose and Blowpipe, capable of simultaneous operation with the shotcreting operation, for removal of Rebound and dust.

### Provide uniformly mixed shotcrete with no evidence of segregation or improper mixing.

### Batch, mix, and supply shotcrete using either dry bagged premix supply in accordance with ASTM C928 or ready-mix supply.

### Batch and convey ready-mix supplied shotcrete at a rate that produces a consistent application of shotcrete. Provide steady conveyance to avoid delays. Do not use shotcrete that has stiffened excessively or is more than 60 minutes old from the time of batching.

## Surface Preparation

### Before shotcrete is applied to any surface, including surfaces of previously applied shotcrete, thoroughly clean such surfaces of dirt, mud, debris, snow, ice, oil, loose particles, curing compound, Rebound, and any other deleterious matter.

### Prepare surfaces for shotcreting in accordance with ACI 506R. Use water or air jets to clean the surfaces to receive shotcrete. Use compressed air only to clean rock surfaces that have a tendency to Slake from contact with water.

### Spray all surfaces to be shotcreted with water not more than 1 hour prior to application of the shotcrete. Allow wetted surfaces to dry to a Saturated Surface Dry condition prior to application of the shotcrete. If necessary, use a Blowpipe and compressed air free of oil to facilitate removal of surface water.

### Temporarily plug the outer pipe ends of any Weep Drains to prevent the entry of the shotcrete or Rebound materials.

## Temperatures

### Do not apply shotcrete during periods of heavy rain or high winds or when the ambient temperature is at or below 5°C or is forecast to fall below 5°C within 24 hours of placing. Do not apply shotcrete to any surface that has a temperature less that 5°C.

### The in place shotcrete temperature is to be between 10°C and 25°C at the time of placement.

## Application

### Apply shotcrete to prepared surfaces in accordance with ACI 506R. Apply shotcrete only after the surfaces to receive shotcrete have been inspected by the Minister. Rectify any defects, including any identified by the Minister.

### Do not apply shotcrete to any surface on which there is running or free standing water.

### Apply shotcrete to the specified full thickness in a single layer, provided it does not Slough or become delaminated. If multiple lifts are required, scrape or broom the previous shotcrete lifts prior to the time of set to remove any loose material, Rebound, Overspray, laitance, or any other material that may impair bond of subsequent layers.

### Use a Blowpipe during the course of the work to remove accumulations of Rebound and Overspray from areas to be shotcreted. Do not reuse the Rebound and Overspray.

### Employ suitable devices to allow access to the work for shotcreting such that hoses, equipment, or personnel do not damage fresh shotcrete.

### Do not allow sand pockets to form in the placed shotcrete. Cut out any such pockets and replace with new shotcrete.

### Leave the shotcrete surface in a natural gun state unless otherwise specified.

### Provide a minimum cover of 50 mm of shotcrete over any anchors, reinforcing steel or other metal embedments.

### Provide a dense, firmly adhering coating of shotcrete.

## Curing and Protection

### Cure and protect the shotcrete in accordance with ACI 506.2 and the following.

### Continuously moist cure shotcrete surfaces for a minimum period of 7 consecutive days at a minimum temperature of 10°C or until an in place compressive strength of 20 MPa has been reached. Use wet burlap and polyethylene sheet or water sprays to provide moist curing.

### Do not use membrane curing compounds unless authorized by the Minister.

### If in place compressive strength samples are used to determine curing or protection requirements, extract and deliver cores to the Minister as specified in clause 1.4.2.

## Installation of Weep Drains

### Install Weep Drains in joints, fractures, and faults by drilling into the rock or by other means authorized by the Minister.

### Drill holes at least [1000] mm into the rock where active seepage is occurring. Provide Weep Drains at a maximum spacing of [3000] mm. Fix Weep Drains in place by locally dry-packing grout adjacent to the collar of the hole. Do not allow the grout to obstruct the flow of water into the drains.

### After shotcreting, provide additional Weep Drains at locations where visible signs of water including seepage or damp spots occur, as required by the Minister.

## Installation of Anchors

### Provide threadbar and shotcrete anchors at the locations, spacing, and with the depth of embedment specified in the Contract Documents.

### Use percussion, rotary, or other drilling equipment to drill a hole of sufficient diameter, free of bends or protrusions, and without undue softening or loosening of the surrounding rock.

### Drill holes using air circulation.

### Clean holes with water or other means authorized by the Minister, to remove all drill cuttings, debris, and other deleterious material prior to anchor installation.

### Provide centralizers to centre the anchors in the hole.

### Maintain temperatures of grout contact surfaces above 5°C at the time of grouting, and for at least 48 hours after grout placement.

### Place grout by pumping methods using equipment approved by the Minister.

### Protect threadbar anchors against disturbance until the grout has attained the specified minimum compressive strength.

## Repair of Shotcrete

### Whenever possible, correct deficiencies while the shotcrete is still plastic.

### Remove and replace shotcrete that fails to bond to rock surfaces or does not conform to the specified requirements or which is damaged at any time during the performance of the Work. Hand patching is not permitted.

## Environmental Requirements

### Remove Rebound and dispose of it in the waste disposal areas on-Site as authorized by the Minister or off-Site waste disposal facilities.

### Contain all wastewater including that from washing shotcreting equipment, in settlement ponds. Do not release any water from the settlement ponds until it meets the Regulatory Requirements authorities. Place waste materials from settling ponds in waste disposal areas on-Site as authorized by the Minister or off-Site waste disposal facilities.

### Provide disposal bins at the Minister’s site laboratory for collecting waste concrete and other test materials. Empty the bins when required by the Minister.

**END OF SECTION**

# General

## References

### Provide precast concrete structures in accordance with the following standards (latest revision) except where specified otherwise.

### Alberta Building Code (ABC)

### American Concrete Institute (ACI)

#### ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

### American Society for Testing and Materials (ASTM)

#### ASTM A276 Standard Specification for Stainless Steel Bars and Shapes.

#### ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

#### ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete.

### Canadian General Standards Board (CGSB)

#### CAN/CGSB-1.181 Ready-Mixed Organic Zinc-Rich Coating.

### Canadian Standards Association (CSA)

#### CAN/CSA-A3000 Cementitious Materials Compendium.

#### CAN/CSA-A23.1 Concrete Materials and Methods of Concrete Construction.

#### CAN/CSA-A23.2 Methods of Test for Concrete.

#### CSA-A23.3 Design of Concrete Structures.

#### CAN/CSA-A 23.4 Precast Concrete – Materials and Construction.

#### CSA-G30.5 Welded Steel Wire Fabric for Concrete Reinforcement.

#### CSA-G30.14 Deformed Steel Wire for Concrete Reinforcement

#### CSA-G30.15 Welded Deformed Steel Wire Fabric for Concrete Reinforcement.

#### CAN/CSA-G30.18 Billet-Steel Bars for Concrete Reinforcement.

#### CSA-G40.20 General Requirements for Rolled or Welded Structural Quality Steel.

#### CSA-G40.21 Structural Quality Steel.

#### CAN/CSA-G164 Hot-Dip Galvanizing of Irregularly Shaped Articles.

## Submittals

### Provide the following submittals.

### Structural design calculations, mix designs, and shop drawings for the precast concrete structures, stamped and signed by a Professional Engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta, at least 20 days prior to manufacture.

### Certified copies of the results of the tests specified in clause 1.3 prior to delivering any structure to the Site.

### Certified copy of mill test reports of reinforcing steel showing physical and chemical analysis results at least 20 days prior to fabrication.

### Manufacturer’s written instructions for handling, assembling and repairing precast concrete elements, and repairing damaged galvanized coating prior to performing the work.

## Quality Control

### Have precast concrete structure designs performed by a Professional Engineer registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.

### During manufacture, perform the following tests in accordance with CAN/CSA-A23.2 for each day concrete is placed.

#### Concrete compressive strength tests at 28 days after concrete placement for at least 2 cylinders obtained from a batch of concrete randomly selected from a particular day’s pour.

#### Slump tests for the same batch of concrete.

#### Air content tests for the same batch of concrete.

### [Notify the Minister at least 5 days prior to pouring concrete for the precast concrete structures.]

## Delivery, Storage, and Handling

### Inspect each shipment of material and timely replace any damaged material.

### Handle and transport large precast concrete panels in a vertical position.

### Handle all precast concrete elements in accordance with the manufacturer’s instructions, utilizing the lifting devices and holes provided.

# Products

## Materials

### Provide materials in accordance with the following.

### Precast Concrete Structures:

#### Design precast concrete structures in accordance with CSA-A23.3 and CAN/CSA-A23.4 to resist the governing combination of loads and other requirements as specified below:

##### Dead load: Due to the self-weight of the structure. [Use a minimum load factor of 1.25, and where required include an impact factor due to handling.]

##### Earth load: Saturated unit weight of backfill of [21 kN/m3 and a lateral earth pressure coefficient at-rest of 0.5]. [Use a minimum load factor of 1.25.]

##### Surcharge load: Equivalent to the greater of 300 mm of earth surcharge or due to the compaction equipment to be used for backfilling. [Use a minimum load factor of 1.5.]

##### Hydrostatic loads: Phreatic level at the full supply level or at the top of the concrete with water in the structure or the structure empty. [Use a minimum load factor of 1.25.]

##### Occupancy live loads on platforms: [4.8] KPa. [Use a load factor of minimum 1.5.]

##### Other live loads: [Snow] [wind] [earthquake] loads in accordance with the ABC. [Use a minimum load factor of 1.5.]

##### Provide solid walls or slabs having a minimum uniform thickness of [150] mm.

##### Provide a minimum concrete clear cover for reinforcement of [30] mm.

#### Design and provide lifting hardware and holes in each precast concrete element.

#### Concrete reinforcement: Billet-steel deformed bars in accordance with CAN/CSA G30.18, Grade 400 or welded wire in accordance with [CSA-G30.5] [CSA-G30.14] [CSA-G30.15] with a minimum yield strength of 485 MPa.

### Structural steel: In accordance with CSA-G40.21, Grade 300W except provide Grade 350W for hollow steel sections, with a minimum zinc coating of 610 g/m2 in accordance with CAN/CSA-G164.

### Connection bolts: [Galvanized bolts in accordance with ASTM A307.] [Stainless steel bolts in accordance with ASTM A276 Type 304.]

### Butyl rubber sealant: Conseal CS 302 manufactured by Concrete Sealants Inc. or Kent Seal No. 2 manufactured by Hamiliton Kent Ltd.

### Non-shrink, Sulphate-resistant cementitious grout: [Sika Grout 212SR as manufactured by Sika Canada, Masterflow 928 as manufactured by BASF or Sulphate Resistant Grout as manufactured by Basalite Concrete Products.] with a minimum compressive strength of [45] MPa at 28 days.

### Gate embedded parts: Refer to Section [ ].

## Concrete Mix

### Proportion concrete mixes in accordance with ACI 211.1.

### Provide concrete for the precast concrete structures in accordance with the following:

|  |  |  |
| --- | --- | --- |
| **Property** | **Requirement** | **Standard or Test Method** |
| [Cement  | Type HS or HSb Sulphate Resistant | CAN/CSA-A3000 |
| Class of Exposure | F–1 | CAN/CSA-A23.1 |
| Minimum cement content | 340 kg/m3 |  |
| Maximum water/cement ratio | 0.50 |  |
| Min. compressive strength @ 7 days | 21 MPa | CAN/CSA-A23.2-14C |
| Min. compressive strength @ 28 days | 30 MPa | CAN/CSA-A23.2-14C |
| Maximum coarse aggregate size | 20 mm | CAN/CSA-A23.2-2A |
| Slump at discharge | 80 mm +/- 20 mm | CAN/CSA-A23.2-5C |
| Air content | 5% to 8% | CAN/CSA-A23.2-4C] |

### Concrete Aggregates: In accordance with CAN/CSA-A23.1, and consisting of clean, hard, dense, durable, and uncoated sand particles and rock fragments.

### Water: Clean and free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis, and other deleterious substances, and in accordance with CAN/CSA-A23.1.

### Air entraining admixture: In accordance with ASTM C260/C260M.

### Obtain the Minister’s authorization prior to using any other chemical admixtures. Do not use calcium chloride or any admixture formulated with calcium chloride.

## Shop Fabrication

### Install concrete reinforcement and other embedded parts in accordance with CAN/CSA-A23.1.

### Produce, place, cure, and finish concrete in accordance with CAN/CSA-A23.1 and CAN/CSA-A23.4, except where specified otherwise.

### Do not remove precast concrete components from the casting form bed until the concrete has attained a minimum compressive strength of 21 MPa.

### Continuously moist cure all precast concrete components at a minimum temperature of 5°C or steam cure until the concrete has attained a minimum compressive strength of 21 MPa.

### Provide finished concrete surfaces that are smooth, hard, and uniformly textured, and free of surface defects, irregularities, and other imperfections.

### [ ].

# Execution

## Excavation and Preparation of the Foundation

### Excavate the structure foundation to the lines, grades, slopes, and elevations specified in the Contract Documents.

### The Minister will identify unsuitable bearing soils when encountered at the earth foundation level. Perform [excavation, as classified by the Minister,] [Authorized Structure Over-Excavation] to remove unsuitable bearing soils and replace with [fill materials] [Authorized Fill Placement] as directed by the Minister.

### Compact the base of the excavation to provide a firm foundation of uniform density beneath the entire structure.

### Provide care of water to permit the work to be carried out in the dry.

### Provide bedding material as specified in the Contract Documents.

## Installation

### Install the precast concrete structure at the locations, and to the lines, grades, slopes, and elevations specified in the Contract Documents. The tolerance from the specified lines, grades, slopes, and elevations is +/-25 mm.

### Assemble the precast concrete structures in accordance with the manufacturer’s written instructions.

### Apply a 25 mm diameter bead of joint sealant between all connecting precast concrete elements to form a watertight joint. Fill all lifting holes or unused bolt holes with non‑shrink cementitious grout.

### Commence backfilling operations only after the Minister has inspected the installation. Rectify defects, including any identified by the Minister.

### Place and compact fill adjacent to the structure as specified in the Contract Documents.

### Within 600 mm of the structure, remove stones larger than 80mm from the fill material. Place fill in lifts not exceeding 100 mm in thickness, and compact to the specified density using pneumatic or other mechanical hand tamping equipment.

### Compact each lift of fill at the moisture content and to the density specified in Section 02331 – Fill Placement.

### Clean the structure of any accumulations of soil and debris.

## Repair and Replacement of Damaged Concrete

### Replace any element that suffers structural damage including cracking or other damage, which in the opinion of the Minister, compromises its strength, performance or durability.

### Examine all concrete surfaces and clearly mark out spalled or other areas to be repaired. Obtain the Minister’s authorization of the delineated repair areas and the proposed method and equipment to be used for the repairs prior to commencing the work.

### Completely remove all damaged concrete down to sound concrete. Remove microfractured surfaces resulting from the initial concrete removal process.

### Sawcut the perimeter perpendicular to the surface to a minimum depth of 25 mm. Do not use any repair method that produces a featheredge.

### Prior to placing repair mortar, clean and dampen the surfaces to obtain a saturated surface dry condition except where the repair technique requires a dry surface.

### Place the polymerized cementitious mortar in accordance with the manufacturer’s written instructions. [Treat the surface of the concrete to be repaired with a compatible acrylic bonding agent as authorized by the Minister prior to mortar filling.]

### Construct the repair area slightly proud of the general surface and then grind it to match.

### Following repairs, promptly initiate curing and protection in accordance with CAN/CSA-A23.1.

### Provide completed repair areas that are tightly bonded to the underlying concrete, and are free of shrinkage cracks or hollow void areas.

## Repair of Damaged Galvanized Coating

### Repair damaged galvanized surfaces with a zinc-rich paint that is in accordance with CAN/CGSB-1.181.

### Power tool clean surfaces to be repaired to a bright metal surface. Apply multiple coats of zinc-rich paint in accordance with the manufacturer’s written instructions to obtain a minimum dry film thickness of 50 microns or greater where required by the paint manufacturer.

**END OF SECTION**

# General

## References

### Provide bedding grout in accordance with the following standards (latest revision) except where specified otherwise.

### Canadian Standards Association (CSA)

#### CAN/CSA-A23.2 Methods of Test for Concrete.

## Quality Control

### Compressive Strength Tests by the Contractor:

#### Engage an independent CSA certified and qualified concrete testing laboratory, with a permit to practice in Alberta, to sample and test bedding grout.

#### Conduct compressive strength test of grout in accordance with CAN/CSA-A23.2–1B.

#### Perform at least 1 strength test, consisting of 3 cubes, for each type of grout placed in any given day.

#### The compressive strength is acceptable if the average of the 3 cubes for each test exceeds the specified value and no individual cube is more than 3.5 MPa below the specified value.

## Quality Assurance

### Compressive Strength Tests by the Minister:

#### The Minister may conduct compressive strength testing of grout in accordance with CAN/CSA-A23.2–1B. The frequency of testing will be as determined by the Minister.

#### Each strength test will consist of 3 cubes.

#### The compressive strength is acceptable if the average of the 3 cubes for each test exceeds the specified value and no individual cube is more than 3.5 MPa below the specified value.

## Submittals

### Provide the following submittals.

### Manufacturer’s written instructions for storing and installing grout at least 5 days prior to delivery to the Site.

### Compressive strength test results within 48 hours of the break date.

## Delivery, Storage, and Handling

### Inspect each shipment of material and timely replace any damaged material.

### Store bedding grout indoors in original packages protected from the weather and moisture, and in accordance with the manufacturer’s instructions.

# Products

## Materials

### Provide materials in accordance with the following.

### Standard Bedding Grout: Non-shrink Portland Cement grout such as [Sika Grout 212 as manufactured by Sika Canada] [Masterflow 713 Plus as manufactured by BASF] [Non Shrink Grout as manufactured by Basalite Concrete Products] or [ ] with a minimum compressive strength of [45] MPa at 28 days.

# Execution

## Mixing

### Mix bedding grout, using proportions specified in writing by the manufacturer with a mechanical grout mixer authorized by the Minister, to produce a uniform, thoroughly blended grout.

### Mix bedding grout as close to the form as possible and transport bedding grout quickly and in a manner that prevents segregation. Continuously agitate prepared grout until used.

### Dispose of bedding grout not used within 30 minutes after mixing or that shows signs of stiffening. Do not re-temper grout.

## Preparation

### Clean all surfaces that will be in contact with bedding grout of grease, oil, laitance, loose, or other deleterious materials.

### Saturate surfaces for a minimum of 24 hours prior to placing grout. Remove excess water to leave a surface damp condition at the time of grouting.

### Notify the Minister at least 24 hours prior to placing bedding grout. Do not place grout until authorized by the Minister.

## Installation

### Place bedding grout in accordance with the manufacturer’s written instructions. Do not dry pack grout.

### Construct formwork to contain grout. Caulk formwork to prevent leakage. Vent high points to allow entrapped air to escape during grouting.

### Place bedding grout at ambient temperatures between 10°C and 25°C.

### Moist cure bedding grout at temperatures at or above 10°C. Use 2 layers of burlap, tied securely in position, and keep continuously wet for a minimum of 7 consecutive days.

**END OF SECTION**