

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA-A23.1- Concrete Materials and Methods of Concrete Construction.
  - .2 CAN/CSA-O86.1- Engineering Design in Wood (Limit States Design).
  - .3 CSA O121- Douglas Fir Plywood.
  - .4 CSA O151- Canadian Softwood Plywood.
  - .5 CSA O153- Poplar Plywood.
  - .6 CSA O437 Series- Standards for OSB and Waferboard.
  - .7 CSA S269.1- Falsework for Construction Purposes.
  - .8 CAN/CSA-S269.3- Concrete Formwork.

**1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal and the Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Formwork materials:
  - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O121 CAN/CSA-O86.1, CSA O437 Series, CSA-O153.
- .2 Form ties:
  - .1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm dia. in concrete surface.
- .3 Form release agent: non-toxic, biodegradable, low VOC,.
- .4 Falsework materials: to CSA-S269.1.
- .5 Void form to section 033000.
- .6 Fillets for chamfered corners: hardwood type, 25mm x 25mm, maximum length possible.

**Part 3 Execution**

**3.1 FABRICATION AND ERECTION**

- .1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Obtain Departmental Representative's approval for use of earth forms framing openings not indicated on drawings.
- .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .4 Fabricate and erect falsework in accordance with CSA S269.1 and COFI Exterior Plywood for Concrete Formwork.
- .5 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CAN/CSA-A23.1.
- .6 Align form joints and make watertight. Keep form joints to minimum.
- .7 Use 25 mm chamfer strips on external corners unless noted otherwise
- .8 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .9 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections. Assure that all anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .10 Clean formwork in accordance with CAN/CSA-A23.1, before placing concrete.
- .11 **WINTER CONSTRUCTION**
  - .1 Remove ice and snow from within the forms.
  - .2 The use of de-icing salts will not be permitted.
  - .3 Unless formwork and concrete construction proceed within a heated enclosure, do not use water to clean out completed forms. Use compressed air or other means to remove foreign matter.
- .12 Construct formwork to maintain the following maximum tolerances:
  - .1 Deviation from horizontal and vertical lines:  
6mm in 3000 mm  
12mm in 12000 mm
  - .2 Deviation in cross sectional dimensions of beams: plus or minus 6mm.
  - .3 In addition to tolerances specified, any exposed concrete surface must be level, flat and plumb (vertical) within a tolerance of 3 mm in 3000 mm.

**3.2 REMOVAL AND RESHORING**

- .1 Leave formwork in place for following minimum periods of time after placing concrete.
  - .1 4 days for walls and sides of beams.
- .2 Remove formwork when concrete has reached 75 % of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .3 Provide all necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .4 Re-use formwork and falsework subject to requirements of CAN/CSA-A23.1.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Concrete Institute (ACI)
  - .1 ACI 315R-, Manual of Engineering and Placing Drawings for Reinforced Concrete Structure.
- .2 American National Standards Institute/American Concrete Institute (ANSI/ACI)
  - .1 ANSI/ACI 315-, Details and Detailing of Concrete Reinforcement.
- .3 Canadian Standards Association (CSA)
  - .1 CAN/CSA-A23.1-, Concrete Materials and Methods of Concrete Construction.
  - .2 CAN3-A23.3-, Design of Concrete Structures for Buildings.
  - .3 CAN/CSA-G30.18-, Billet-Steel Bars for Concrete Reinforcement.
  - .4 CAN/CSA-G40.21-, Structural Quality Steels.
  - .5 CAN/CSA-G164-, Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .6 CSA W186-, Welding of Reinforcing Bars in Reinforced Concrete Construction.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings including placing of reinforcement in accordance with Section 01 33 00- Submittal Procedures.
- .2 Indicate on shop drawings, bar bending details, lists, quantities of reinforcement, sizes, spacings, locations of reinforcement and mechanical splices if approved by Department Representative, with identifying code marks to permit correct placement without reference to structural drawings. Indicate sizes, spacings and locations of chairs, spacers and hangers. Prepare reinforcement drawings in accordance with Reinforcing Steel Manual of Standard Practice - by Reinforcing Steel Institute of Canada .
- .3 Detail lap lengths and bar development lengths to CAN3-A23.3, unless otherwise indicated.

**1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal and the Waste Reduction Workplan.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Substitute different size bars only if permitted in writing by Department Representative.

- .2 Reinforcing steel: billet steel, deformed bars, grade 400 for all bars, to CAN/CSA-G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CAN/CSA-30.18.
- .4 Cold-drawn annealed steel wire ties: to CSA G30.3.
- .5 Chairs, bolsters, bar supports, spacers: to CAN/CSA-A23.1.
- .6 Mechanical splices: subject to approval of Department Representative.
- .7 Plain round bars: to CAN/CSA-G40.21.

## **2.2 FABRICATION**

- .1 Fabricate reinforcing steel in accordance with CAN/CSA-A23.1, ANSI/ACI 315, and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain Department Representative's approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of Department Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

## **Part 3 Execution**

### **3.1 FIELD BENDING**

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by Department Representative.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars which develop cracks or splits.

### **3.2 PLACING REINFORCEMENT**

- .1 Place reinforcing steel as indicated on reviewed placing drawings and in accordance with CAN/CSA-A23.1.
- .2 Prior to placing concrete, obtain Department Representative's approval of reinforcing material and placement.
- .3 Ensure cover to reinforcement is maintained during concrete pour.

- .4 Clear distance between adjacent bars and splices shall be not less than 1.4 times the largest bar diameter, not less than 1.4 times the largest aggregate, and not less than 30 mm.
- .5 Reinforcing steel shall, where not otherwise shown on the structural drawings, be protected by concrete cover over the reinforcement as follows:
  - .1 Where concrete is formed against earth, not less than 75 mm.
  - .2 In girders, beams, and columns exposed to the weather or in contact with soil, not less than 50 mm to principal reinforcement 35 M or smaller, and not less than 40 mm to ties and stirrups.
  - .3 For bars larger than allowed in above, provide 1.5 times the bar diameter for exposed conditions and 1.0 times the bar diameter for conditions not exposed.
  - .4 Concrete covers shall be maintained within  $\pm 5$  mm of that required.

### 3.3 REINFORCING FOR MISCELLANEOUS CONCRETE

- .1 Unless indicated otherwise on drawings, reinforce miscellaneous concrete to one of the following:
  - Sections up to 100 mm thick: 10M @ 500 o.c. each way mid depth
  - Sections up to 150 mm thick: 10M @ 300 o.c. each way mid depth
  - Sections up to 200 mm thick: two layers of 10M @ 400 o.c. each way
  - Thickened Edges: 4-15M cont.
  - Cylindrical Sections up to 400 mm dia: 4-15M cont. c/w 10M ties @ 300 o.c.
  - Cylindrical Sections up to 600 mm dia: 5-20M cont. c/w 10M ties @ 450 o.c.

**END OF SECTION**

## **PART 1        GENERAL**

### **1.1            REFERENCES**

- .1        American Society for Testing and Materials (ASTM)
  - .1        ASTM C260-, Specification for Air-Entraining Admixtures for Concrete.
  - .2        ASTM C494-, Specification for Chemical Admixtures for Concrete.
- .2        Canadian Standards Association (CSA)
  - .1        CSA-03001-08 Cementitious Materials Compendium
  - .2        CAN/CSA-A23.1-, Concrete Materials and Methods of Concrete Construction.
  - .3        CAN/CSA-A23.2-, Methods of Test for Concrete.

### **1.2            CERTIFICATES**

- .1        Submit certificates in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CAN/CSA-A23.1.
- .3        Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CAN/CSA-A23.1.

### **1.3            QUALITY ASSURANCE**

- .1        Minimum 4 weeks prior to starting concrete work, submit proposed quality control procedures in accordance with Section 01 45 00 - Quality Control for Department Representative's approval for following items:
  - .1        Cold weather concrete.
  - .2        Curing.
  - .3        Formwork removal.

### **1.4            INSPECTION AND TESTING**

- .1        Concrete testing shall be carried out by an independent testing agency, certified by CSA in accordance with the requirements of CSA A283.
- .2        Concrete testing shall be paid for by the Contractor.
- .3        The testing agency shall be responsible for sampling, initial curing and transporting of test cylinders to the Laboratory.
- .4        Notify the Department Representative and Testing Agency at least 24 hours prior to each concrete pour.
- .5        Provide free access to all portions of work and cooperate with appointed firm.
- .6        Concrete testing shall consist of three (3) test cylinders taken for every 50 cubic meters or less of each class of concrete placed each day. One (1) cylinder to be tested at 7 days, the remaining two (2) cylinders to be tested at 28 days.
- .7        One (1) additional test cylinder shall be taken during cold weather concreting, and be cured on jobsite under same conditions of concrete it represents.
- .8        One (1) slump test and one (1) air content test shall be taken for each set of test cylinders taken.
- .9        One (1) slump test shall be taken before and one (1) slump test shall be taken after the addition of plasticizer to the concrete mix.
- .10       Testing of concrete shall be performed in accordance with CAN/CSA-A23.2.
- .11       Test results shall be issued to the Department Representative, Contractor, Owner and Ready-mixed Concrete Supplier. Test reports are to be numbered consecutively beginning with number one, and identify the location of the concrete placement in the project.
- .12       Required retesting will be paid for by the Contractor.

- .13 The Department Representative may order additional testing any time even though the required tests indicate the strength requirements have been met. In this instance, the Owner will pay for those tests that meet the specified requirements and the Contractor shall pay for those that do not.
- .14 Non-destructive methods for testing concrete shall be according to CAN/CSA-A23.2.

## **1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal and the Waste Reduction Workplan.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Portland cement, supplementary cementing materials and hydraulic slag to CSA-03001, Cementitious Materials Compendium
- .2 Water: to CAN/CSA-A23.1.
- .3 Aggregates: to CAN/CSA-A23.1. Coarse aggregates to be normal density. The fine aggregate for concrete slabs that are to be finished with dry shake hardener shall contain a maximum of 0.4% clay particles as determined by CSA Test A23.2-3A "Clay Lumps in Natural Aggregate". Test results shall be submitted to Department Representative for review.
- .4 Air entraining admixture: to ASTM C260.
- .5 Chemical admixtures: to ASTM C494. Department Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .6 Concrete retarders: to ASTM C494 water based, low VOC. Do not allow moisture of any kind to come in contact with the retarder film.
- .7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents.
  - .1 Compressive strength: 40 MPa at 7 days.
  - .2 Consistency:
    - .1 Fluid: to ASTM C827. Time of efflux through flow cone (ASTM C939), under 30s.
    - .2 Flowable: to ASTM C827. Flow table, 5 drops in 3s, (ASTM C109, applicable portion) 125 to 145%.
    - .3 Plastic: to ASTM C827. Flow table, 5 drops in 3 s, (ASTM C109, applicable portions) 100 to 125 %.
    - .4 Dry pack to manufacturer's requirements.
- .9 Non premixed dry pack grout: composition of non metallic aggregate Portland cement with sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 40 MPa at 7 days.
- .10 Drilled concrete Wedge Anchors: to be Hilti Kwik-Bolt, Power-Stud, or Ucan Wedge Anchors. Sized as per drawings. Minimum embedment length of all Wedge Anchors to be 150mm unless noted otherwise.
- .11 Screen Tube and Epoxy Anchors: Hilti HIT Adhesive System, Power-Fast Epoxy System, Ucan Poly-All Renovation Anchoring System, Epcon A7, or Sikadur Injection Gel Fast Set System of sizes specified on the drawings.
- .12 Void Form: Void form shall be one of the following:



- .1 system made decomposable cardboard slab and beam forms
- .2 GeoVoid compressible void filler manufactured by PlastiSpan. GeoVoid compressible void filler system to be designed and installed to fail at a maximum net uplift pressure of 1.2 kPa when combined with concrete self weight alone. Void space shown on drawings is sized for cardboard void form. For GeoVoid, increase depth of void to provide space for crushed material. Contractor to provide shop drawings sealed by a professional engineer registered in the province of Saskatchewan. Shop drawings to provide detailed information regarding slab uplift pressures.

## **2.2 MIXES**

- .1 Concrete to be proportioned according to the notes on the drawings for the Location and Class of Exposure indicated.
- .2 Do not change concrete mix without prior approval of Department Representative. Should change be proposed, submit new mix design to Department Representative for review.
- .3 Each load of ready-mixed or transit-mixed concrete delivered to the project site shall be accompanied by duplicate delivery slips providing the following information:
  - .1 Name and location of batch plant;
  - .2 Date and serial number of ticket;
  - .3 Name of contractor;
  - .4 Specific designation of job (name and location);
  - .5 Specific class or designation of concrete in conformance with Table 6;
  - .6 Amount of concrete in cubic metres;
  - .7 Truck number, cumulative total, and/or load number; and
  - .8 Time loaded or time of first mixing of cement and aggregate.
- .4 Space shall also be provided for the following information, which is to be registered by the producer's representative on at least two copies of the delivery ticket, after discharge has been completed:
  - .1 The time that the load arrived on the project;
  - .2 The time that the discharge of load was started;
  - .3 The time that the discharge of load was completed.
- .5 Use of accelerating admixtures in cold weather only when approved by Department Representative. If approved, the use of admixture will not relax cold weather placement requirements.
- .6 Use set-retarding admixtures during hot weather only when approved by the Department Representative.
- .7 Use plasticizers when required to place concrete of specified slump.
- .8 No water shall be added to the concrete mix on site.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- .1 Obtain Department Representative's approval before placing concrete. Provide 48 hours notice prior to placing of concrete.
- .2 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .3 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

- .4 In locations where new concrete is dowelled to existing work, drill holes in existing concrete. Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.
- .5 Do not place load upon new concrete until authorized by Department Representative.

### 3.2 CONSTRUCTION

- .1 Do cast-in-place concrete work in accordance with CAN/CSA-A23.1.
- .2 Anchor bolts.
  - .1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
  - .2 Coordinate anchor bolt locations and quantities with gate manufacturer.

### 3.3 COLD WEATHER REQUIREMENTS

- .1 When the air temperature is at or below 5 degrees C. or when there is a probability of it falling to that limit during the placing or curing period, cold weather requirements shall be applicable.
- .2 Protection shall be provided for newly placed concrete by means of suitable enclosures, coverings and/or adequate insulation as indicated in CAN/CSA-A23.1, Clause 7.4.
- .3 Concrete shall not be placed on or against reinforcement, formwork, ground or any surface that is at a temperature less than 5°C.
- .4 The temperature of the concrete at all surfaces shall be maintained at not less than 10°C for a minimum of three days or for the time necessary to attain a minimum strength of 15 mPa. Means shall be provided to humidify the air within enclosures and to keep the concrete and formwork continuously moist if dry heat is used.
- .5 At the end of the specified protection period the temperature of the concrete shall be reduced gradually to the temperature differential shown in CAN/CSA-A23.1, Table 21.
- .6 Accelerator or so-called anti-freeze compounds shall not be permitted unless otherwise approved in writing by the Department Representative.
- .7 All protective coverings shall be kept clear of the concrete and form surfaces to permit free circulation of air and shall be maintained intact for at least 24 hours after artificial heat is discontinued.

### 3.4 HOT WEATHER REQUIREMENTS

- .1 When the air temperature is at or above 27°C or when there is a probability of its rising to 27°C during the placing period (as forecast by the local official meteorological office) special effort shall be made to maintain the temperature of the concrete no more than that stipulated in CSA A23.1 Table 14.
- .2 Time of initial mixing to complete discharge shall not exceed one hour and fifteen minutes.
- .3 In extremely hot weather, the formwork, reinforcement, and concreting equipment shall be protected from the direct rays of the sun, or cooled by fogging and evaporation.

### 3.5 PROTECTION FROM DRYING OF EXPOSED CONCRETE SURFACES

- .1 When the rate of surface evaporation exceeds .5 kg/m<sup>2</sup>.hr take measures to reduce surface evaporation from concrete.
- .2 When the rate of surface evaporation exceeds .75 kg/m<sup>2</sup>.h erect windbreaks around the sides of the structural element.
- .3 When the rate of surface evaporation exceeds 1.0 kg/m<sup>2</sup>.h take one or more of the following measures:
  - .1 Dampen the subgrade prior to placing the concrete;
  - .2 Erect sunshades over the concrete during finishing operations;

- .3 Lower the concrete temperature;
  - .4 Cover the concrete surface with white polyethylene sheeting between the various finishing operations;
  - .5 Apply fog spray immediately after placement and before finishing. Care shall be taken to prevent accumulation of water that may reduce the quality of the cement paste;
  - .6 Begin curing of the concrete immediately after trowelling; or
  - .7 Place and finish at night.
- .4 The rate of evaporation shall be estimated from CAN/CSA-A23.1 Figure D1 of Appendix D using measurements of relative humidity, concrete temperature, air temperature and wind velocity.

### **3.6 CURING**

- .1 Initial and final curing of all concrete surfaces to CAN/CSA-A23.1.
- .2 The basic curing period shall be extended until the concrete achieves two-thirds of its specified 28 day compressive strength.

### **3.7 CONSTRUCTION JOINTS**

- .1 The location and detail of all construction joints not detailed on the structural drawings shall be approved by the Department Representative.
- .2 Where fresh concrete is to be placed against concrete which has set or has partially set, the surface of the set or partially set concrete shall be roughened, cleaned of all laitance, and bonding agent applied prior to the placement of fresh concrete.
- .3 Concrete placed in column forms shall be struck off flush with the underside of the member above.

### **3.8 FINISHING OF FORMED SURFACES**

- .1 All formed surfaces unless noted otherwise shall be finished with a Rough form in accordance with CAN/CSA-23.1, Clause 7.9.2.4 and to Department Representative's approval. Remove all protrusions, ridges and other irregularities.

### **3.9 DEFECTIVE CONCRETE**

- .1 Concrete not meeting the requirements of the Specifications and drawings shall be considered defective concrete.
- .2 Concrete not conforming to the lines, details and grade specified herein or as shown on the drawings shall be modified or replaced at the Contractor's expense and to the satisfaction of the Department Representative. Finished lines, dimensions and surfaces shall be correct and true within tolerances specified in the Formwork Section of these Specifications.
- .3 Concrete not properly placed resulting in excessive honeycombing and all honeycombing and other defects in critical areas of stress, shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Department Representative.
- .4 Concrete of insufficient strength or improper consistency shall be, as required by the Department Representative, subject to one or more of the following:
  - .1 Changes in mix proportions for the remainder of the work.
  - .2 Cores drilled and tested from the areas in question as directed by the Department Representative and in accordance with CAN/CSA-A23.2. The test results shall be indicative of the in-place concrete.
  - .3 Load testing of the structural elements in accordance with CAN/CSA-A23.3.
  - .4 The changes in the mix proportions and the testing shall be at the Contractor's expense.

- .5 Concrete failing to meet the strength requirements of this Specification shall be strengthened or replaced at the Contractor's expense and to the satisfaction of the Department Representative.

**3.10 PATCHING CONCRETE**

- .1 After the removal of the forms concrete surfaces may be subject to inspection by the Department Representative.
- .2 All exposed metal form ties, nails, wires, shall be removed, fins broken off and all loose concrete removed.
- .3 Form tie pockets shall be thoroughly wetted and patched with patching concrete followed by proper curing.
- .4 Honeycombed and other defective surfaces shall be chipped away to a depth of not less than 25mm with the edges perpendicular to the surface, thoroughly wetted and patched with patching concrete followed by proper curing.
- .5 Patching concrete shall be thoroughly compacted into place and finished in such a manner as to match the adjoining concrete. The design mix of the patching concrete shall be approved by the Department Representative.
- .6 Fill with grout and finish smooth all openings and holes provided to accommodate the various trades. Work after all pipes, conduits, ducts and such items have been placed.

**3.11 VOID FORM**

- .1 Install cardboard void form in strict accordance with manufacturers recommendations. Contractor to ensure that void form decomposes after casting concrete.
- .2 Install GeoVoid compressible void filler system in strict accordance with manufacturers recommendations.

**END OF SECTION**