

1. GENERAL

1.1 RELATED SECTIONS

- .1 Contract Documents apply to and govern the Work of this section.

1.2 REFERENCES

- .1 ASTM C900-06 - Test Method for Pullout Strength of Hardened Concrete.
- .2 CAN/CSA-O86.1-01 Consolidation - Engineering Design in Wood.
- .3 CAN/CSA-S269.3-M92 (R2003) - Concrete Formwork.
- .4 CSA A23.1-04/A23.2-04 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .5 CSA O121-08 - Douglas Fir Plywood.
- .6 CSA O151-04 - Canadian Softwood Plywood.
- .7 CSA S269.1-1975 (R2003) - Falsework for Construction Purposes.

1.3 COORDINATION REQUIREMENTS

- .1 Coordination: Coordinate with other work and sub-trades having a direct bearing on work of this section.

1.4 DESIGN REQUIREMENTS

- .1 Design of concrete formwork and adequate shoring systems are sole responsibility of the Contractor.

1.5 SUBMITTALS

- .1 Shop Drawings: Submit Shop Drawings indicating placement joints, control joints, and false joint patterns for review. Include proposed tie pattern.

1.6 REGULATORY REQUIREMENTS

- .1 Conform to applicable safety regulations for erection, maintenance and removal of formwork.

1.7 DELIVERY, STORAGE, AND PROTECTION

- .1 Protect material and Work from damage by frost and weather.

2. PRODUCTS

2.1 MATERIALS

- .1 Formwork Materials: To CSA A23.1, precoated plywood sheets.
- .2 Form Oil: Colorless mineral oil, free of kerosene, with viscosity min. 70 maximum 110 seconds Saybolt Universal at 38 degrees C, flashpoint minimum 150 degrees C open cup. Form coating to be of type that will permit the application of paint or parging to the exposed concrete surfaces.
- .3 Plywood:
 - .1 Douglas Fir, conforming to CSA O121 or Softwood conforming to CSA O151 as required to resist design loads imposed upon the forming system; regular grade select tight face; sound undamaged sheets with clean, true edges.
 - .2 Exposed Architectural Finished Concrete including painted or epoxy-coated concrete: Use high density overlaid one side material to CSA O121, smooth surface, undamaged sheets with clean, true edges. Re-use no more than five times.
- .4 Lumber: Fir or spruce species, No. 2 Grade or better to the design requirements of CAN/CSA-O86.1 to resist applied loads required of the forming system.
- .5 Anchorage Devices (including nails, bolts, spikes, and lag screws): Sized to ensure all formwork loading is adequately resisted.
- .6 Steel Forms: Minimum 1.9 mm well matched, tight fitting, and adequately stiffened to support weight of concrete without deflection.
- .7 Form Ties: All concrete with unexposed (non-architectural) finishes or covered by an applied architectural finish:
 - .1 Snap off metal ties that will break off approximately 15 mm below the surface and permit a flush finish, to resist all forces.
 - .2 Snap off metal ties with 50 mm length cone to resist all forces to permit a recessed finish. Pattern to approval of Consultant. Use in swimming pool forming. Fill recessed holes with cementitious waterproofing to flush with wall surface.
- .8 Form Ties: All concrete exposed to view, including painted and/or epoxy-coated concrete, unless specifically exempted on the drawings or in a room finish schedule:
 - .1 Removable ties shall resist all forces and shall permit a recessed or flush finish. Pattern to be symmetrical to approval of Consultant.
- .9 Form Release Agent: Non-staining, non-volatile type. Exposed concrete finishes use low viscosity agent to eliminate bugholes.
- .10 Fillets for Chamfered Corners: Minimum 12 x 12 mm wood.

- .11 Void Forms: Moisture resistant Dynavoid 40144 or approved equivalent; structurally sufficient to support weight of wet concrete until final set; minimum 100 mm thick.

3. EXECUTION

3.1 EXAMINATION

- .1 Verify lines and levels before proceeding with formwork. Ensure that dimensions agree with drawings.

3.2 ERECTION

- .1 Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of CAN/CSA S269.3.
- .2 Arrange and assemble formwork to permit easy dismantling and stripping, so that concrete is not damaged during its removal.
- .3 Align joints and make watertight, to prevent leakage of mortar and disfigured appearance of concrete. Keep form joints to a minimum. Obtain approval of Consultant for location of form joints in exposed work.
- .4 Verify all elevations. Revise elevations as required to the approval of the Consultant to proper elevations. Ensure piles project into grade beams and pile caps as indicated on drawings.
- .5 Remove all loose concrete from tops of piles and footings. Ensure tops of piles and footings are sound concrete.
- .6 Obtain approval of Consultant for use of earth forms. When using earth forms, hand-trim sides and bottoms, and remove loose dirt prior to placing concrete.
- .7 Provide bracing to ensure stability of formwork as a whole. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.
- .8 Chamfer external corners of beams, columns and walls 12 mm when exposed or as noted.
- .9 Construct formwork to maintain the following maximum tolerances unless closer tolerances are required for special conditions such as elevators:
 - .1 Horizontal and vertical lines – 10 mm in 20 m.
 - .2 Building dimensions indicated on drawings and position of columns, walls, partitions: 6 mm
 - .3 Cross sectional dimensions of columns or beams: plus or minus 3 mm.
 - .4 Camber, Beams: 0.2% of span unless otherwise noted.
 - .5 Camber, Slabs: 0.1% of span for all spans over 3 m.
- .10 Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices, and embedded parts. Do not apply form release agent where concrete surfaces are to receive special finishes or coverings that are affected by agent.

- .11 Do not reuse formwork that contains surface defects that could impair the appearance of finished concrete. Do not patch formwork.

3.3 FORMING OF ARCHITECTURAL AND EXPOSED CONCRETE

- .1 Erect formwork to result in exposed concrete surfaces free of unsightly cold joints, blemishes, bugholes, honeycombing and cracking. Acceptable symmetrical joint patterns are mandatory.
- .2 Control joint and pour break spacing outlined on structural drawings are maximum allowable. More frequent spacing will likely be required to conform to architectural requirements.
- .3 All horizontal and vertical joints must result in a satisfactory symmetrical pattern, as approved in advance of forming by the Consultant.
- .4 Allow for horizontal joints that must extend on all sides of a given space or spaces at the same elevation, unless otherwise detailed.
- .5 Allow for horizontal joints at the top of all openings and extend as required, unless otherwise detailed.
- .6 Allow for vertical joints each side of all openings and extend to the underside of slabs or deck, unless otherwise detailed.
- .7 Horizontal reglets must be placed on both sides of all pour breaks in walls, railings, beams, and/or slabs.
- .8 All V-joints or reglets in walls and railings must also extend over the top of the wall or railing.
- .9 Caulk or otherwise seal all form joints including corners to prevent loss of fine material.
- .10 Add V-joints and reglets to forms at all vertical and horizontal pour breaks and as noted or detailed. Caulk V-joint and reglet formwork to prevent bleeding of fines from concrete.
- .11 Replace damaged forms and forms with poor surfaces with new material at direction of Consultant.
- .12 Chamfer all exposed edges and corners.
- .13 Fill all interior V-joints, reglets and form tie holes with approved cementitious waterproofing material. Finish to be flush and match texture of adjacent concrete.
- .14 Form, cast and finish a sample panel of minimum size 3000 x 3000 mm. Include construction joint, control joint, reinforcing, water stop, and forming material to be used throughout the project.
- .15 Have forming inspected before concrete placement. Place concrete as specified. Fill all reglets and form tie holes and rub finish as specified herein, to approval of Consultant.
- .16 Panel to remain on site as basis for acceptability of all concrete finishes. Protect the finished work from elements.

3.4 INSERTS

- .1 Set sleeves, ties, anchor bolts and other inserts and openings in concrete as required by other trades.
- .2 Limit penetrating sleeves, ducts, pipes or other openings to those detailed on the structural drawings or approved by the Consultant.
- .3 All sleeves, openings, etc., shown on structural drawings to be checked with the architectural and mechanical drawings. Sleeves, openings, etc., not shown on the structural drawings to be reviewed by the Consultant.
- .4 See additional information also provided in the structural drawings.

3.5 FORM REMOVAL

- .1 Comply with CSA S269.1 for dismantling all falsework.
- .2 Do not remove forms, shores, and bracing until concrete has gained sufficient strength to carry its own weight, construction loads, and the design loads that are expected to be imposed upon it.
- .3 Remove forms not directly supporting weight of concrete only after ensuring that the stripping operations will not damage concrete but not before a minimum of twenty four (24) hours from completion of concrete placement.
- .4 Retain shores under structural members for a minimum of fourteen (14) days or until the concrete has attained 75% of the required 28 days strength, whichever occurs later.
- .5 Verify in-place strength by field cylinders or insert pullout type tests in accordance with ASTM C900.
- .6 Remove formwork progressively and in accordance with code requirements so that no shock loads or unbalanced loads are imposed on structure.
- .7 Loosen forms carefully. Do not wedge pry bars, hammers, or tools against concrete surfaces.
- .8 Reshore structural members as required for design or construction conditions. Construction must be reshored to carry all future anticipated construction loading unless otherwise approved in writing by the Consultant.

3.6 FINISHING FORMED SURFACES

- .1 Provide finishes in accordance with CSA A23.1, and as follows:
 - .1 Rough Finish Concrete Surfaces Not Exposed to View: Place concrete against true and plane forms. Cut off form ties a minimum of 15 mm below concrete surfaces. Patch tie holes and defects. Remove fins exceeding 5 mm.
 - .2 Sack Rubbed Finish. Exterior Surfaces and Interior Surfaces Exposed to View Including Ceilings: Place concrete against medium density plywood or steel. Fill reglets, tie holes and other defects. Remove fins, grind smooth and rub with cement sand slurry, as directed in CSA A23.1.
- .2 Do not parge unless approved by Consultant.

3.7 FORM CLEANING

- .1 Clean forms as erection proceeds, to remove foreign matter. Remove cuttings, shavings, and debris from within forms. Flush completely with water or compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- .2 During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out completed forms, unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.

3.8 FIELD QUALITY CONTROL

- .1 Field Services:
 - .1 Field Services by the Consultant consists of periodic visits to the site for generally familiarizing with the progress and quality of the Work and to determine in general if it is progressing according to the contract documents, and the necessary paperwork related to these services.
 - .2 Field Services by the Consultant do not in any way relieve the Contractor of responsibility to execute the Work according to contract documents and contract drawings.
- .2 Damage: Make good all areas damaged in connection with the Work regardless of the limits of the contract as shown on the drawings.

3.9 CLEANING

- .1 Clean up and remove from site, all rubbish and surplus material remaining from this Work.

END OF SECTION

1. GENERAL

1.1 SECTION INCLUDES

- .1 The Contract Documents apply to and govern the Work of this section.

1.2 REFERENCES

- .1 ACI 315-99 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, Details and detailing of concrete reinforcement.
- .2 ASTM A497/A497M-07 - Steel Welded Wire Reinforcement, Deformed, for Concrete.
- .3 CAN/CSA-G30.18-M92 (R2007) - Billet-Steel Bars for Concrete Reinforcement.
- .4 CSA A23.1-04/A23.2-04 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .5 CSA A23.3-04 - Design of Concrete Structures.
- .6 CSA W186-M1990 (R2007) - Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .7 CSA W47.1-03 - Certification of Companies for Fusion Welding of Steel.

1.3 COORDINATION REQUIREMENTS

- .1 Coordination: Coordinate with other work and sub-trades having a direct bearing on work of this section.

1.4 SUBMITTALS

- .1 Shop Drawings:
 - .1 Provide placing drawings and bar lists and include placing dimensions and necessary placing details. Use large scale details for areas of congested reinforcement.
 - .2 Include details of all doweling.
 - .3 Details in accordance with ACI 315 unless specifically detailed otherwise.
 - .4 Unless otherwise noted on drawings, bar splices to be 40 bar diameters or 400 mm minimum for horizontal splices and 30 bar diameters or 350 mm minimum for vertical splices.
 - .5 Provide corner bars at corners and intersections of grade beams and walls, in accordance with the structural drawings.
 - .6 Check Shop Drawings prior to submission to Consultant.
 - .7 Consultant's review does not relieve Contractor of his responsibility for accuracy of shop drawings.

1.5 QUALITY ASSURANCE

- .1 Perform Work in accordance with CAN/CSA A23.1/A23.2.

- .2 Perform welding to CSA W186.
- .3 Welders: Workmen qualified under CSA W47.1.

1.6 DELIVERY, STORAGE, AND PROTECTION

- .1 Store and protect reinforcing steel and welded wire fabric to prevent deterioration or contamination by foreign matter.
- .2 Do not use contaminated or deteriorated material.

2. PRODUCTS

2.1 MATERIALS

- .1 Reinforcing Steel: To CSA G30.18, Grade 400, 400 MPa yield grade special low alloy deformed billet steel for welding, with equivalent carbon content not exceeding 0.5 and/or for bending where bending radius is smaller than recommended standards.
- .2 Dimensions are in metric designation.
- .3 Welded Wire Fabric: To ASTM A497/A497M-07, in flat sheets, plain finish.
- .4 Chairs, Bolsters, Bar Supports, Spacers: Adequate for strength and support of reinforcing. Where concrete is exposed to elements or where rust is possible, use plastic or non-corrosive material.
- .5 Tie Wire: Minimum 1.5 mm annealed type, or patented system approved by the Consultant.
- .6 Galvanized Reinforcement: To ASTM A123/A123M, minimum zinc coating 610 g/m².

2.2 FABRICATION

- .1 Shop fabricate reinforcing steel from sizes indicated, and to reviewed shop drawings.
- .2 Fabricating details in accordance with CSA A23.1.
- .3 Identify steel.
- .4 Hooks, bends, laps, and similar details to CSA A23.1, and Metric Supplement of the Reinforcing Steel Institute of Ontario (RSIO) Manual of Standard Practice.
- .5 Do bending cold unless otherwise approved by Consultant.
- .6 Dowel columns and walls into foundations using same reinforcing as that in column and wall unless noted otherwise.
- .7 Provide horizontal "L" shaped corner bars of same cross section and spacing as horizontal bars.
- .8 Provide all additional support bars as required to support all main reinforcement indicated.
- .9 Provide 10M stirrup support bars in hooks or corners of beam stirrups unless noted otherwise on drawings.

- .10 Provide 10M "U" spacers at 3000 mm on centre horizontally and 1500 mm on centre vertically to hold wall reinforcing mats in position.
- .11 Provide mesh over electrical conduit, ductwork, or piping buried in slabs with strips of 152 x 152 x MW13.3 x MW13.3 welded wire fabric 300 mm each side. If principal slab reinforcement is placed above conduit, then place strips under conduit. Position of reinforcing steel takes precedence over conduit, ductwork, or piping.
- .12 Locate reinforcing splices, not indicated on drawings, at points of minimum stress. Location of splices is to be approved by the Consultant.
- .13 Where indicated, weld reinforcing bars in accordance with the applicable requirements of CSA W186. Do not weld reinforcing at any location without written approval of the Consultant.
- .14 Test all welded reinforcement splices unless noted. Such testing to be paid for by the Owner.
- .15 Allow for 2.0 tonnes of extra reinforcing to be placed as directed. Keep records of reinforcing used and other Work requested. Credit contract with unused balance at completion of Work.

3. EXECUTION

3.1 PREPARATION

- .1 Clean reinforcing to CSA A23.1.

3.2 PLACEMENT

- .1 Place reinforcement in accordance with reviewed shop drawings and/or contract drawings.
- .2 Support and space reinforcing in alignment and position indicated and as follows:
 - .1 Concrete Slabs On Grade: Support reinforcement on support bars or concrete brick.
 - .2 Structural slabs and toppings: support reinforcement on bar chairs.
 - .3 The minimum concrete cover to be provided is as follows unless detailed otherwise on drawings or specified elsewhere: (dimensions in mm).

CLEAR CONCRETE COVER SCHEDULE					
Exposure Condition	Exposure Class				
	N	F-1, F-2, S-1, S-2	C-XL, C-1, C-3, A-1, A-2, A-3	C-2, C-4	Epoxy-Coated Bars
Cast Against and Permanently Exposed to Earth (Footings and Piles)	3" (75mm)	3" (75mm)	3" (75mm)	-	No
Ratio of Cover to Nominal Diameter	1.0	1.5	2.0	1.0	
Ratio of cover to Nominal Maximum Aggregate Size	1.0	1.5	2.0	1.0	

.4 Cover and protection for reinforcement in concrete utilized in a corrosive environment shall be as per CSA A23.1.

.5 Ensure alignment of reinforcing steel as follows:

<u>Tolerance, plus or minus</u>	<u>Item</u>
5 mm	Slabs
10 mm	Other structural members
50 mm	Rebar bends & ends

.6 Place reinforcing in accordance with CSA A23.1. Refer to structural drawings for minimum splices. Splices to be Class B unless noted.

.7 Use non-corrosive supports for reinforcing when concrete is exposed.

.8 Supply bar support chairs for top reinforcing bars in sufficient quantity to not exceed 1200 mm average spacing in each direction.

.9 Supply horizontal reinforcing spacers in walls to ensure reinforcing does not move during placement.

.10 Do not rebend or straighten reinforcing steel after initial fabrication unless so indicated on drawings.

.11 Ensure reinforcing is clear and free of loose scale, dirt, oil, and rust and other foreign coatings.

.12 Support slab on grade and structural slab reinforcing at 900 mm maximum on centre.

- .13 Where a structural concrete members is identified on the drawings, or specifications, it is required to have a fire resistance rating providing minimum concrete cover to reinforcing steel, in accordance with Chapter 2 of the Supplement to National Building Code, "Fire Performance Ratings".

3.3 SPLICING OF REINFORCEMENT

- .1 Splice reinforcement to CSA A23.3 unless indicated otherwise.

3.4 WELDING OF REINFORCEMENT

- .1 Weld reinforcing bars in accordance with CSA W186.

3.5 MINIMUM REQUIREMENTS

- .1 Unless otherwise shown or specified:
 - .1 Minimum requirements for slabs on grade and topping to be 152 x 152 – MW 13.3 x MW 13.3.
 - .2 Minimum requirement for 130 mm slabs and over, 10M at 300 each way.

3.6 FIELD QUALITY CONTROL

- .1 Field Services:
 - .1 Field Services by the Consultant or his representative consists of periodic visits to the site for generally familiarizing with the progress and quality of the Work and to determine in general if it is progressing according to the contract documents, and the necessary paperwork related to these services.
 - .2 Field Services by the Consultant or his representative do not in any way relieve the Contractor of his responsibility to carry out the Work per the contract documents and contract drawings.
 - .3 The word "Consultant" is used in this specification to mean "Consultant" or "Consultant's Representative".
- .2 Inspection:
 - .1 General Contractor is responsible for reinforcing size, location and proper placement.
 - .2 Inspection for size, location and proper placement may be made at any time at discretion of Consultant or Consultant's representative.
 - .3 Remove and replace reinforcement not in accordance with the drawings.
 - .4 Provide adequate notice of scheduled pours to facilitate inspection.
- .3 Damage:
 - .1 Make good all areas damaged in connection with the contract regardless of the limits of the contract as shown on the drawings.

3.7 CLEANING

- .1 Clean up and remove from site, all rubbish and surplus material remaining from this Work.

END OF SECTION

1. GENERAL

1.1 SECTION INCLUDES

- .1 The Contract Documents apply to and govern the Work of this section.

1.2 REFERENCES

- .1 ASTM C33-08 - Concrete Aggregates.
- .2 ASTM C94/C94M-09 - Ready-Mixed Concrete.
- .3 ASTM C260-06 - Air-Entraining Admixtures for Concrete.
- .4 ASTM C494/C494M-08a - Chemical Admixtures for Concrete.
- .5 ASTM C1017/C 1017M-07 - Chemical Admixtures for Use in Producing Flowing Concrete.
- .6 ASTM D1752-04a(2008) - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .7 ASTM D2822-05 - Asphalt Roof Cement.
- .8 CAN/CSA A3000-08 - Cementitious Materials Compendium.
- .9 CSA A23.1-04/A23.2-04 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .10 CSA A23.3-04 - Design of Concrete Structures.
- .11 CSA A283-06 - Qualification Code for Concrete Testing Laboratories.
- .12 CSA G30.18-92 (R2007) - Billet-Steel Bars for Concrete Reinforcement.
- .13 Concrete Reinforcing Steel Institute (CRSI) where noted.
- .14 Alberta Building Code 2006.
- .1 Provincial safety standards where applicable.
- .2 Erection, Maintenance and Removal of Formwork Conform to applicable safety regulations.

1.3 DESIGN REQUIREMENTS

- .1 Contractor is responsible for design of concrete formwork and adequate shoring systems.
- .2 Specific concrete and reinforcing specification requirements are included on structural drawings.

1.4 COORDINATION REQUIREMENTS

- .1 Coordination: Coordinate with other work and sub-trades having a direct bearing on work of this section.
- .2 Scheduling: If requested, prepare and submit for review a schedule and proposal outlining the following:
- .1 Time of major structural pours.
- .2 Heating, curing and protection provisions.
- .3 The concrete forms stripping procedures including elapsed time from concrete placement.
- .4 Shoring and re-shoring procedures and timing of removal of shores.

1.5 QUALITY ASSURANCE

- .1 Failure to comply with the requirements of these specifications will result in the structure being considered potentially deficient. In such a case the Consultant or his representative shall have the right to require one or more of the following:
 - .1 Changes in the mix proportions for the remainder of the Work.
 - .2 Additional curing on those portions of the structure represented by test specimens that failed to meet specified requirements.
 - .3 Non-destructive testing (refer to CSA A23.2, Annex A).
 - .4 Test cores drilled from portions of the structure in question in accordance with CSA A23.2, Test Method 14C.
 - .5 Load testing of structure or structural elements in accordance with CSA A23.3.
 - .6 Reinforce by additional construction or replace as directed by the Consultant at Contractor's expense when concrete is judged inadequate by structural analysis or be results of load tests.
 - .7 Such other tests as the Consultant may specify.
 - .8 Note: Cores should not be drilled from the tension zone of a structural member because the presence of cracks may adversely affect the measured compressive strength.
- .2 Additional testing may be ordered by the Consultant at any time even though required tests indicate that strength requirements have been met. In this instance, Owner will pay for those tests that meet the specified requirements and the Contractor will pay for the test and the repair to work that does not.
- .3 Pay for all costs of evaluation tests and additional engineering analysis that are required to demonstrate the adequacy of the structure where it does not meet the requirements of this specification and drawings or where concrete has been placed before formwork and reinforcing have been inspected and approved by Consultant.

1.6 SUBMITTALS

- .1 Provide submittals accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide data on all concrete making materials specified or proposed.
 - .2 Provide all proposed concrete mix designs.
 - .3 Provide data on all concrete accessories specified or proposed.
- .3 Shop Drawings: Prepare and submit for review a location diagram and proposed details for all planned construction joints to the Engineer for approval prior to the concrete pour.
- .4 Test Data: Submit test data confirming specified concrete strengths are being achieved.
 - .1 Tests to be performed by a testing laboratory approved by the Consultant or his representative and paid for by the General Contractor.
 - .2 Allow for casual labour and expenses in connection with materials testing.
 - .3 Submit two (2) copies of test results to Structural Engineer, General Contractor and Consultant immediately upon completion of testing.
 - .4 Compressive Strength Tests:

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- .1 One set of three (3) standard test specimens to be made for each class of concrete in any one days pour of more than five (5) cubic metres. For pours of more than sixty (60) cubic metres, one (1) set per each sixty (60) cubic metres.
 - .2 One additional standard test specimen to be made during cold weather construction. Cure this specimen on job site under same conditions as concrete it represents.
 - .3 Concrete to be sampled at the point of deposit of the concrete into the forms.
 - .4 Test specimens to be cast, cured and tested in accordance with CSA A23.2 by personnel from the designated testing laboratory.
 - .5 For each set of test specimens, a slump test and entrained air test is to be included (for air entrained concrete).
 - .5 Concrete Test Reports:
 - .1 Test Reports to include the following information:
 - .1 Project Name.
 - .2 Date and time of sampling.
 - .3 Supplier, truck number and time of concrete truck departure from concrete plant.
 - .4 Specified strength.
 - .5 Cement type.
 - .6 Admixtures.
 - .7 Exact location in structure of sampled concrete.
 - .8 Slump.
 - .9 Maximum aggregate size.
 - .10 Air content, if applicable.
 - .11 Test strength and age at test.
 - .12 Date specimen received in the testing laboratory.
 - .13 Technical identification.
 - .6 Concrete tests will be considered satisfactory if the average of all sets of three (3) consecutive strength tests equal or exceed the specified strength and no individual strength test is more than 3.5 MPa (500 psi) below the specified strength.
 - .5 Submit proposed methods of protection of concrete when air temperatures are expected to be above 25 degrees C or below 5 degrees C.
 - .6 Submit responses to all site review reports stating that all reported defects and deficiency items were corrected or what action taken.
- 1.7 DELIVERY, STORAGE, AND PROTECTION**
- .1 Store and protect materials and work from damage by frost and weather, and deterioration or contamination by foreign matter.
 - .2 Do not use contaminated or deteriorated materials.

2. PRODUCTS

2.1 MATERIALS

- .1 Ready Mix Concrete: To CSA A23.1 supplemented by ASTM C94/C94M.
- .2 Cement: To CSA A3001.
- .3 Water: Potable, to CSA A23.1.
- .4 Aggregates: to CSA A23.1 and ASTM C33. Nominal size 20 mm coarse aggregate, 10 mm for toppings. Contractor may use smaller size.
- .5 Chemical Admixtures: To ASTM C494/C494M or ASTM C1017/C1017M.
- .6 Air Entrainment: To ASTM C260.
- .7 Concrete Curing Compound: Chlorinated liquid rubber type, membrane forming.
- .8 Joint Filler: To ASTM D1752, resilient, non-extruding, non-bituminous.
- .9 Non-shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 16 MPa at 2 days and 48 MPa at 28 days to CSA A23.1.
- .10 Mastic Cement: To ASTM D2822, plastic cement, cutback asphalt.
- .11 Bonding Agent: Polymer resin emulsion, for mixing with cement and water, similar to "Daraweld". For bonding two concretes, to CSA A23.1.
- .12 Vapour Barrier: 10 mil polyethylene film.

2.2 CONCRETE MIXES

- .1 Supply "Controlled Concrete" with the minimum compressive strengths as defined by CSA A23.1 as noted on the drawings in accordance with the following table:

TYPE	LOCATION	CLASS OF EXPOSURE	CEMENT TYPE
1	ALL CONCRETE	F1	GU

REQUIREMENTS FOR SPECIFYING CONCRETE						
EXPOSURE CLASS	MAXIMUM WATER TO CEMENTING MATERIALS RATIO	MINIUMUM SPECIFIED COMPRESSIVE STRENGTH (MPa) AT AGE (d) AT TEST	AIR CONTENT CATEGORY AS PER TABLE	CURING TYPE		
				NORMAL CEMENT	HVSCM 1	HVSCM 2
SF-1	0.50	30 MPa @ 28 DAYS	1	2	3	2

- .2 Please refer to table for fly ash content.
- .3 Aggregate nominal maximum size shall satisfy the requirement of CSA A23.1.
- .4 Air Content: All mix types to be air-entrained in accordance with CSA A23.1.
- .5 Do not change concrete mix proportions or source material for architectural concrete without written approval of the Consultant.

2.3 ADMIXTURES

- .1 Use accelerating admixtures in cold weather only when approved by the Consultant. If approved, the use of admixtures will not relax cold weather placement requirements.
- .2 Do not use calcium chloride or any admixtures containing chloride ion.
- .3 Use set-retarding admixtures during hot weather only upon a written approval of the Consultant to prevent cold joints in concrete.
- .4 Admixtures must be used in strict accordance with the manufacturer's recommendations.
- .5 Non-specified admixtures would not be permitted unless approval in writing by the Consultant is obtained.

3. EXECUTION

3.1 WORKMANSHIP

- .1 Maintain accurate records of poured concrete items to indicate date, location of pour, quantity, air temperature and associated concrete testing.
- .2 Ensure that reinforcement and inserts are not disturbed during concrete placement.
- .3 In locations where new concrete is dowelled to existing work, drill holes in existing concrete and insert steel dowels and pack solidly with non-shrink grout to positively anchor dowels.
- .4 Excessive honeycomb or embedded debris in any concrete shall deem it defective. Remove and replace defective concrete.

3.2 CONCRETE COVER OVER REINFORCEMENT

- .1 Ensure alignment of reinforcing steel as follows:

<u>Tolerance, plus or minus</u>	<u>Item</u>
5 mm	Slabs
10 mm	Other structural members
50 mm	Rebar bends & ends

- .2 The minimum concrete cover to be provided is as follows unless detailed otherwise on drawings or specified elsewhere:

CLEAR CONCRETE COVER SCHEDULE					
Exposure Condition	Exposure Class				
	N	F-1, F-2, S-1, S-2	C-XL, C-1, C-3, A-1, A-2, A-3	C-2, C-4	Epoxy-Coated Bars
Cast Against and Permanently Exposed to Earth (Footings)	3" (75mm)	3" (75mm)	3" (75mm)	-	No
Ratio of Cover to Nominal Diameter	1.0	1.5	2.0	1.0	
Ratio of cover to Nominal Maximum Aggregate Size	1.0	1.5	2.0	1.0	

- .3 The cover and protection for reinforcement in concrete utilized in a corrosive environment shall be as per CSA A23.1.

3.3 CONCRETE SUPPLY

- .1 Ready mix concrete to be used.
- .2 All concrete to contain a cement dispersing agent in accordance with the manufacturer's recommendations.

3.4 PLACING CONCRETE

- .1 Notify Consultant a minimum of 24 hours prior to commencement of concrete placement.
- .2 Place concrete in accordance with CSA A23.1 and additionally, as specified herein.
- .3 Clean previously placed concrete with steel brush and dampen prior to placing the next layer. Use mild acid only on approval by the Consultant.
- .4 In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels, and set solidly with H.I.T. two (2) parts adhesive as supplied by Hilti, or approved alternative.
- .5 Ensure all hardware and all other items to be cast into concrete are held securely and will not cause undue hardship in placing concrete.
- .6 Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and other critical items are not disturbed during concrete placement.
- .7 Wire all waterstop to reinforcing to prevent folding during concrete placement.
- .8 Revise, reseal and correct improperly positioned reinforcing hardware and other embedded items immediately before concrete placement.
- .9 Place concrete in approximately horizontal layers such that each lift can be vibrated into the previous lift to that lines and levels indicated on the drawings.
- .10 Place concrete directly into its final position in forms. Do not spread concrete with vibrators.
- .11 Maximum vertical free fall of concrete is not to exceed 1200 mm in unexposed work or 800 mm in exposed work. Confine concrete with a suitable vertical drop pipe to prevent segregation.
- .12 Use internal vibrators in all sections where the sections are sufficiently large and supplement with external vibrators in the event satisfactory surfaces cannot be obtained.
- .13 Place concrete as a continuous operation, stopping only at construction joints indicated on the drawings or with the approval of the Consultant as follows:
 - .1 At centre of span of suspended slabs, beams, and joists.
 - .2 In walls and columns immediately above or below floor construction joints or directly over centroid of pile or pile cap, if applicable.
- .14 Construction joints in walls and grade beams, maximum spacing 12 m or as detailed.
- .15 Construction joints in walls must be watertight.
- .16 Separate exterior slabs on grade from vertical surfaces with 6 mm thick joint filler from bottom of slab to within 6 mm of finished slab surface.
- .17 Consolidate and screed floors, maintaining surface flatness of maximum 3 mm on 3 m. Pitch to drains 20 mm/m nominal, or as indicated on the drawings.

- .18 Use cold weather concreting, curing and protection methods in accordance with CSA A23.1 when the ambient temperature falls below 5°C. When the ambient temperature rises above 25°C, use hot weather concreting, curing and protection methods.
- .19 Maintain accurate records of concrete placement. Record date, location of placement, quantity, air temperature and all associated concrete testing.
- .20 Ensure specified concrete cover around reinforcing is maintained.
- .21 Honeycomb that exceeds 150 mm in any direction or embedded debris in concrete are not acceptable. Notify Consultant upon discovery of such defect.
- .22 Remove and replace defective concrete as directed by the Consultant.

3.5 PLACING OF ARCHITECTURAL AND EXPOSED CONCRETE

- .1 Place concrete in maximum horizontal lifts of 400 mm. Limit length of concrete placement to prevent cold joints.
- .2 Do not place concrete from one end for full height of placement.
- .3 Use sufficient vibration, consolidation and methods to ensure dense smooth concrete lines and surfaces free from bugholes, honeycomb, and cold joints.
- .4 Ensure that vibrator penetrates into the layer of fresh concrete immediately below the layer being placed to prevent stratification.
- .5 In hot weather, use set retarding agents to prevent cold joints, with permission of Consultants.
- .6 Review methods of concrete placing with Consultant prior to placement.
- .7 All concrete that is noted on drawings to receive a sandblast finish shall be rendered to a medium texture using approved equipment. Provide sample area of finish for Consultant's review and approval prior to commencing with work.

3.6 COLD WEATHER CONCRETE WORK

- .1 Cold weather concreting requirements are to be met when temperature falls below 5°C or there is a probability of falling to 5°C or below during the placing period.
- .2 Cold weather construction methods, curing and protection are to conform to CSA A23.1.
- .3 Concrete temperature at placing to be between 15°C and 30°C.
- .4 Placed concrete to be protected and maintained at a temperature of at least 10°C for not less than three (3) days or not less than 20°C for two (2) days and all concrete to be maintained above freezing for a minimum of seven (7) days.
- .5 Concrete to be protected from alternate freezing and thawing for a minimum of fourteen (14) days.
- .6 Protected and heated concrete to be brought gradually to ambient air temperature at a drop of not more than 15°C per 24 hour period.
- .7 Coverings for heating enclosure to be clear of concrete and forming surface for air circulation.
- .8 Frozen or otherwise defective concrete will be rejected.

3.7 HOT WEATHER CONCRETE WORK

- .1 When the air temperature is at or above 25°C or there is a probability of it rising to that limit or above during the placing period, the temperature of the concrete when deposited is not to be more than 25°C. To accomplish this, the mixing water, and if necessary the aggregate are to be cooled.
- .2 Where pours are massive, or where surfaces are to be trowel finished, or wood floated, use a retarder that will slow the initial set of the concrete.
- .3 When the air temperature is at or above 25°C, exposed surface of the concrete are to be shaded from the direct rays of the sun and sheltered from direct wind. Alternatively, all placing and finishing to be done at night.
- .4 Moist cure the concrete instead of using curing compounds.

3.8 TOLERANCES

- .1 Concrete work to be within the tolerances listed below:
 - .1 Variations of the linear building lines from established position in plan: 6 mm.
 - .2 Variation in cross-sectional dimensions of thickness of slabs: minus 6 mm OR plus 6 mm.
 - .3 Variations from the level or from grades indicated for surfaces of slabs shall not exceed 3 mm under a 3 m straight edge immediately after trowelling.
- .2 Remove and replace concrete that does not meet the above requirements at no cost to the Owner.

3.9 PATCHING

- .1 Patch imperfections when concrete is defective as follows:
 - .1 Chip down edges perpendicular to surface.
 - .2 Wet the area and brush on 1:1 cement-sand grout.
- .2 Patch with 1:2 cement-sand mortar with 10% hydrated lime.

3.10 INSERTS/EMBEDDED PARTS/OPENINGS

- .1 Provide formed openings where required for pipes, conduits, sleeves, and other work to be embedded passing through concrete members.
- .2 Refer to mechanical and electrical drawings for sleeves and openings required through structural components. These must not reduce the structural capacity. Locations and sizes not shown on the structural drawings are to be approved in writing by the Consultant.
- .3 Maximum size of electrical conduit in structural slabs is 1/3 of solid portion of slab thickness, and where more than two are adjacent to each other, they must be spaced at least 100 mm apart. Conduit must be placed in middle third of slab unless otherwise specified or approved in writing by the Consultant.
- .4 Reinforce around openings as noted on structural drawings.
- .5 Accurately locate and set in place, items that are to be cast directly into concrete.
- .6 Coordinate work of other sections and cooperate with the trade involved in forming and/or setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts. Do not perform work unless specifically indicated on drawings or approved prior to installation.
- .7 Install all concrete accessories in accordance with drawings and manufacturer's recommendations; straight, level, and plumb. Ensure adequate support to prevent movement during concrete placement.

- .8 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close temporary ports or openings with tight fitting panels, flush with inside of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.
- .9 The only application where the use of fixed pins will be acceptable is for the installation of strapping and fixing and care must be taken to do as little damage as possible to the surrounding concrete.
- .10 Do not use aluminum inserts or conduits.

3.11 GROUTING

- .1 Grout beneath steel base and bearing plates after the steel has been erected. This grout is to be expanding type and be mixed and used according to the manufacturer's printed instructions.

3.12 CURING

- .1 Concrete curing to CSA A23.1.
- .2 Basic Curing: Keep concrete surface continuously moist until concrete temperature due to hydration has peaked and dropped several degrees, or for three days at a minimum temperature of 10°C.
- .3 Additional Curing: Immediately following basic curing and before the concrete has dried, cure for an additional four days, maintaining the temperature of the air in contact with the concrete above 10°C.
- .4 Acceptable curing methods:
 - .1 Ponding or continuous sprinkling.
 - .2 Absorptive mat or fabric kept continuously wet.
 - .3 Damp sand, earth, or similar moist material.
 - .4 Continuous steam vapour mist bath not exceeding 70°C.
 - .5 Curing compound.
 - .6 Waterproof paper or plastic film.
 - .7 Other moisture-retaining method approved by the Consultant.
- .5 Do not use curing compounds on concrete surfaces, which are expected to receive topping, hardener, or other type of bonded finish unless approved by the Consultant.
- .6 Protect freshly placed and consolidated concrete against damage or defacement from adverse weather conditions.
- .7 Exposed concrete walking surfaces not to receive an integral hardener: Coat with curing compound or curing method that provides permanent seal.
- .8 In areas with an exposed concrete floor surface, apply the hardener and dust-proofing agent strictly to the manufacturer's instructions.
- .9 Submit proposed methods of protection and curing when air temperature is at or above 25°C or at or below 5°C, or likely to be so with 24 hours of placing time.
- .10 Water for curing shall be clean and free from materials that will cause staining or discoloration of the concrete.
- .11 For horizontal surfaces, spread 50 mm of moist sand over the entire surface and keep saturated with water.

- .12 For vertical surfaces such as walls, columns, piers, loosen the forms, leave them in place and continuously apply water between the form and the concrete surface. Alternatively the forms may be removed and an absorptive woven fabric applied and kept continuously moist.
- .13 If moist curing is not used, then sprayed curing compounds are to be used.
- .14 Curing compounds to be of the liquid membrane type for curing concrete and shall be applied in strict accordance with the manufacturer's printed instructions.
- .15 Curing compounds used for exposed concrete must not discolor the concrete, nor be such as to prohibit the subsequent application of paint, tiles, parging or other coatings.
- .16 For horizontal surfaces, after the completion of finishing operations and immediately after the disappearance of surface moisture, apply the sprayed curing compound.

3.13 PROTECTION

- .1 Protection for concrete to CSA A23.1.
- .2 Under adverse weather conditions, make suitable arrangements to prevent damage to fresh concrete. All forms and reinforcing in contact with fresh concrete must have a surface temperature greater than 5°C.
- .3 Do not place concrete on frozen ground.
- .4 Do not place concrete on soil that has suffered any appreciable change in moisture until the soil has either dried out or been wetted so that its moisture content is normal and equal to that of the surrounding soil.
- .5 Conveying equipment, if supported by formwork, must not impart harmful vibrations to the green concrete nor cause misalignment of forms.
- .6 Protect freshly finished concrete floors from the elements and from defacement due to other construction or building operations. Provide and use tarpaulins or other protective material when necessary to cover completely or enclose all freshly finished concrete floors.

3.14 FIELD QUALITY CONTROL

- .1 Field Services:
 - .1 Field Services by the Consultant or his representative consists of periodic visits to the site for generally familiarizing with the progress and quality of the Work and to determine in general if it is progressing according to the contract documents, and the necessary paperwork related to these services.
 - .2 Field Services by the Consultant or his representative do not in any way relieve the Contractor of his responsibility to carry out the Work per the contract documents and contract drawings.
 - .3 The word "Consultant" is used in this specification to mean "Consultant" or "Consultant's Representative".
- .2 Damage:
 - .1 Make good all areas damaged in connection with the contract regardless of the limits of the contract as shown on the drawings.

3.15 CLEANING

- .1 Clean up and remove from the site all rubbish and surplus material remaining from this work.

END OF SECTION