

1. General

1.1 RELATED REQUIREMENTS

- .1 Section 03 15 00 – Concrete Accessories.
- .2 Section 03 20 00 – Concrete Reinforcing.
- .3 Section 03 30 00 – Cast-in-Place Concrete.
- .4 Section 03 35 00 – Concrete Finishing.
- .5 Section 03 39 00 – Concrete Curing.

1.2 PRICING AND PAYMENT PROCEDURE

- .1 No measurement will be made under this Section.
 - .1 Include formworks pricing in concreting work package in section 03 30 00 – Cast-in-Place Concrete.

1.3 REFERENCES

- .1 Canadian Standard Association (CSA)/CSA International.
 - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .2 CSA O86-14, Engineering Design in Wood.
 - .3 CSA O121-08, Douglas Fir Plywood.
 - .4 CSA O151-09, Canadian Softwood Plywood.
 - .5 CSA O153-13, Poplar Plywood.
 - .6 CSA O325-07, Construction Sheathing.
 - .7 CSA O437 Series-93(R2006), Standards on OSB and Waferboard.
 - .8 CSA S269.1-1975(R2003), Falsework for Construction Purposes.
 - .9 CAN/CSA S269.2-M87(R2003), Access Scaffolding for Construction Purposes.
 - .10 CAN/CSA S269.3-M92(R2008), Concrete Formwork.
 - .11 CSA Z809-08, Sustainable forest management.

1.4 CONTRACTOR'S LIABILITIES

- .1 The Contractor scope of work includes concrete forming, falseworks, their design and installation. No examination or comments from the Representative of the Ministry or anyone else shall relieve the Contractor of assuming solely all risks and liability regarding these parts of work.

- .1 Calculations, layout and construction of formworks are the sole responsibility of the Contractor.

1.5 FORMWORKS AND FALSEWORK DESIGN

- .1 Formwork and falsework design shall be performed by an engineer member of the OIQ employed by the Contractor or mandated to do so.
- .2 Formwork and falsework design shall be done in accordance with laws and regulations in place, including but not limited to the Safety Code for the Construction Industry.
- .3 Special precautions shall be taken during design to limit loads applied on existing structures to values inferior to the maximum allowable loads on these structures.
- .4 Describe the construction sequence incorporated into the design of structures. Show or describe the position of construction joints provided and, if applicable, the principle of formworks and falseworks reuse. Provide vertical construction joint every twenty (20) meters maximum in vertical elements. Submit to the Owner's Representative the position of construction joints for approval.
- .5 Calculations shall be made in accordance with recommendations and loads indicated in ACI 347 and ACI 347.2 guides. Wind loads shall conform to the requirements of the Code de la Construction du Québec 2010.

1.6 ACTIONS AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit descriptions of all formwork materials in direct contact with wet concrete.
- .3 Submit formworks and falseworks shop drawings.
 - .1 The drawings shall bear the seal and signature of a professional engineer, certified by the Ordre des ingénieurs du Québec (OIQ).
- .4 Indicate formwork design data including permissible rate of concrete placement, and temperature of concrete, in forms.
- .5 When falseworks or structural element are connected or lean on an existing structure used as support, shop drawings shall indicate maximum forces transmitted in each direction.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse/recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Place materials defined as hazardous or toxic in designated containers.

- .3 Divert wood materials from landfill to a recycling, reuse or composting facility as approved by the Representative of the Ministry.
- .4 Divert plastic materials from landfill to a recycling, reuse or composting facility as approved by the Representative of the Ministry.
- .5 Divert unused form release material from landfill to an official hazardous material collection site as approved by the Representative of the Ministry.

1.8 ACCEPTABLE MATERIALS

- .1 Where materials are specified by trade name refer to the Instructions to Tenderers for a procedure to be followed in applying for approval of alternatives

2. Products

2.1 MATERIALS

- .1 Formwork materials :
 - .1 For concrete without special architectural features, use wood and wood product formwork materials in accordance with CSA O86, CSA O121, CSA O153 and/or CSA O437 Series.
- .2 Form release agent: use a non-toxic, biodegradable and low VOC product such as :
 - .1 Formshield Pure from Euclid;
 - .2 MasterFinish RL 100 from BASF;
 - .3 King Form Release from Matériaux KING;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .3 Form stripping agent: colourless mineral oil, non-toxic, biodegradable and low VOC, free of kerosene, with viscosity between 15 to 24 mm²/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .4 Falsework materials: according to CSA-S269.1, table 1. Identify materials through quality indices and present data from tests or any certificate of compliance.
- .5 Form ties:
 - .1 For concrete without special architectural features, use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
 - .2 For concrete with an apparent surface, use snap ties complete with plastic cones and light grey concrete plugs. Cone diameter shall be less than 38 mm. Insure concrete cover of 25 mm or more.

- .3 Unless otherwise indicated, use watertight snap ties with a neoprene washer in the centre of the tie, able to resist 12 meters high water pressure for foundation walls and retaining walls. In general, use watertight snap ties for all concrete work considered watertight.
- .4 Sealing mortar for form ties holes. Cementitious, two-component, fast-setting mortar, grey colored and containing a corrosion inhibitor such as :
 - .1 Sikatop 123 Plus or Sikatop 123 Plus Winter Grade if weather conditions require it.
 - .2 Verticoat Supreme from Euclid;
 - .3 Super-Top OV from Matériaux KING;
 - .4 MasterEmaco N 1501HCR Vertical Overhead from BASF;
 - .5 Planitop X or XS from MAPEI;
 - .6 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .6 Refer to section 03 15 00 for concrete accessories.

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 Prior to concreting, clean formwork and treat surfaces with a form stripping agent in accordance with CSA A23.1.
- .3 Obtain the Representative of the Ministry approval for use of earth forms, or for framing openings not indicated on drawings.
- .4 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .5 Fabricate and erect falsework in accordance with CSA S269.1.
- .6 Do not place shores and mud sills on frozen ground. Bottom of excavation shall be protected against frost at all time. Concrete shall never be poured over a frozen surface.
- .7 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .8 Fabricate and erect formwork in accordance with CAN/CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated.

- Insure proper temporary bracing to maintain the shape of formwork from pouring to hardening of concrete.
- .9 Geometric configuration and localisation shall be within tolerances required by CSA A23.1, article 6.4.
 - .10 Align form joints and make them watertight. Keep form joints to minimum. Adequate reinforcements must be placed at the back of the joints between plywood sheets to ensure obtaining a continuous flat surface able to withstand all stages of concreting without deforming or moving.
 - .11 Unless otherwise indicated, use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints.
 - .12 For all sharp angles of exposed concrete, provide 25 mm chamfers, even where no indications are given on drawings.
 - .13 When formwork's height is significant, windows shall be incorporated into the forms to facilitate concreting. Windows shall be placed to limit free fall of concrete and segregation of ingredients during concrete pouring.
 - .1 Minimally, for vertical elements more than three (3) meters high, access window shall be spaced 2.4 meters apart horizontally and vertically.
 - .2 When pumping concrete, descending a trunk down into the casing from the top to limit the drop height is likely to create segregation of concrete during the interruption of pumping or when opening the valve before the descent of the trunk. This method cannot be considered as to guarantee proper placing of concrete – the addition of access window in the formwork should be used.
 - .14 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated. Refer to section 03 15 00 for requirements regarding insulation or dilatation joint.
 - .15 Special care shall be taken in fabrication and erection of formwork for architectural concrete, as indicated on drawings and specifications.
 - .1 It might not be possible to align joints using panels of standard dimensions or maximum spacing between snap ties.
 - .16 When using controlled permeability formwork liner (textile lining), ensure that the following requirements are met:
 - .1 Secure lining taut to formwork to prevent folds.
 - .2 Pull down lining over edges of formwork panels.
 - .3 Ensure lining is new and not reused material.
 - .4 Ensure lining is dry and free of oil when concrete is poured.
 - .5 Application of form release agents on formwork surface is prohibited where drainage lining is used.
 - .6 If concrete surfaces require cleaning after form removal, use only pressurized

water stream in order to not alter concrete's smooth finish.

- .7 Cost of textile lining is included in price of concrete for corresponding portion of Work.
- .17 At least twenty-four (24) hours prior to closing forms, advise the Owner's Representative as to allow inspection of reinforcement.

3.2 ANCHORS, SLEEVES AND EMBEDDED ELEMENTS

- .1 Provide and install into formwork all embedded elements (anchors, sleeves, ducts, machinery anchor bolts, etc.) in accordance with CSA A23.1 article 6.7. Refer to section 03 15 00 – Concrete Accessories for additional requirements.
- .2 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
 - .2 Prior to concreting, ensure, by survey, that all dimensions required in drawings and specifications and tolerances imposed for the implementation are met.
- .3 Tolerances shall be in accordance with standard CSA A23.1 article 6.7.3.
- .4 Sleeves and openings with a side larger than 100 mm shall be examined by the Representative of the Ministry if not indicated on drawings.
- .5 No sleeve, pipe or duct shall be installed and no openings shall be made into a joist, a beam, a slab, slab capitol or a column unless directed otherwise by the Representative of the Ministry.
- .6 When authorized by the Representative of the Ministry, incorporate openings, place sleeves, ties, hangers and any other embedded elements as indicated in drawings.
- .7 Unless otherwise indicated, the following guidelines shall be met when installing sleeves, ducts or pipes :
 - .1 Ducts shall be placed between top and bottom rebars;
 - .2 Ducts shall be spaced apart 300 mm or farther. Maximum dimension of ducts shall be less than a third of the thickness of the concrete element or fifty (50) millimetres, whichever is less. Location of ducts shall be approved by the Representative of the Ministry;
 - .3 Centre-to-centre dimension between sleeves or pipes shall be superior to three (3) times the diameter of the larger element;
 - .4 The exterior diameter of the embedded element shall not be larger than the third of the thickness of the wall, beam or slab into which it is embedded;

- .5 Do not remove or move rebars in order to place embedded elements. If placement of embedded elements is impossible where prescribed, any modification need to be approved by the Representative of the Ministry;
- .6 Nothing shall be embedded into a slab on ground exposed to the effect of bad weather.
- .8 Notify the Representative of the Ministry and wait for his instructions if the preceding requirements cannot be met.
- .9 Coordinate delivery and placement into formworks of embedded elements with subcontractors.
- .10 Aluminium material embedded into concrete shall be covered with a proper coating to prevent aluminium corrosion.

3.3 FORMWORK REMOVAL AND RESHORING

- .1 Leave formwork in place for the following minimum periods of time after placing concrete:
 - .1 One (1) day for footings, abutment and thrust blocks;
 - .2 Three (3) days for walls less than three (3) meters high and beam sides;
 - .3 Five (5) days for walls three (3) to six (6) meters high;
 - .4 Seven (7) days for column;
 - .5 Twenty-eight (28) days for beams, slabs, decks and any other framing elements, or seven (7) days if formworks are replaced immediately by adequate reshoring. Reshores shall remain set in place for twenty-one (21) days. Falsework drawings in accordance with CSA S269.1 shall indicate the method, materials and locations used for reshores. Each drawing shall bear the seal and signature of an engineer certified by the OIQ.
 - .6 Refer to section 03 39 00 – Concrete Curing for the minimum time prior to formwork removal, notwithstanding the indication of the preceding articles. Coordinate the time required before formwork removal with concrete curing.
- .2 Formwork removal will be authorized by the Representative of the Ministry if non-destructive tests demonstrate that the concrete has reached 75% of its computed resistance. The Contractor shall assume all expenses related to those tests and the Representative of the Ministry shall be the sole individual able to evaluate test results. After formwork removal, replace reshores immediately.

- .3 Notwithstanding preceding articles, formwork removal is authorised only when the Representative of the Ministry allows it. The authorization shall be given only if proper methods of curing are ensured, including protection against cold- or hot-weather, rain or any other adverse conditions. Moreover, time prior formwork removal may be increased depending on the process used for concreting, curing conditions and weather conditions.
- .4 The Contractor remains the sole responsible for any damage to concrete following early formwork removal, even if he has been authorized to proceed.
- .5 Provide 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.
- .6 Space reshoring in each principal direction at not more than 3 000 mm apart.
- .7 Reuse formworks and falseworks as indicated in CSA A23.1 standard. Except for exposed surfaces, reuse of formwork is allowed as long as the surfaces are thoroughly cleaned and are not cracked, nor rough.

3.4 PATCHING OF FORM TIE HOLES

- .1 Refer to article 7.9.3 from CSA A23.1 standard for patching of form tie holes.
- .2 All conical cavities left after removal of the plastic cones on the ends of snap ties shall be filled with grout. Proceed according to the instructions of the grout manufacturer. Moisten the surface beforehand. Ensure a smooth finish with the grout blending into the surrounding concrete surfaces. Allow to cure.
- .3 For exposed surfaces (architectural concrete), products used to fill the holes shall have the same texture and color as the concrete. Provide the technical datasheet of the product for approval by the Representative of the Ministry.

3.5 FIELD QUALITY CONTROL

- .1 During inspection of concrete reinforcement, formworks and falseworks shall be inspected as well. Formwork quality and its cleanliness shall be inspected, as well as solidity of falseworks.
- .2 Surveys will be conducted prior to concreting to measure the level of the top of the form.
- .3 The Contractor shall cooperate fully to facilitate testing by allowing access to work site and equipment.
- .4 The Ministry will pay for the costs of tests indicated above.

END OF SECTION

1. General

1.1 RELATED REQUIREMENTS

- .1 Section 03 11 00 – Concrete Forming.
- .2 Section 03 20 00 – Concrete Reinforcing.
- .3 Section 03 30 00 – Cast-in-Place Concrete.
- .4 Section 03 35 00 – Concrete Finishing.
- .5 Section 03 39 00 – Concrete Curing.

1.2 PRICING AND PAYMENT PROCEDURE

- .1 No measurement will be made under this Section.
 - .1 Include concrete accessories costs in items of concrete work in section 03 30 00 – Cast-in-Place Concrete.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C 39/C 39M-14a, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - .2 ASTM C 42/C 42M-13, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - .3 ASTM C 496/C 496M-11, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - .4 ASTM C 881/C 881M-13, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - .5 ASTM C 920-14a, Standard Specification for Elastomeric Joint Sealants;
 - .6 ASTM C 1107/C 1107M-14, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - .7 ASTM D 412-06a (2013), Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - .8 ASTM D 624-00 (2012), Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
 - .9 ASTM D 1751-04 (2013)e1, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .10 ASTM D 1752-04a (2013), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

- .11 ASTM D 2628-91 (2005), Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
- .12 ASTM E 1745-11, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- .13 ASTM E 1993/E 1993M-98(2013), Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- .2 Canadian Standard Association (CSA)/CSA International.
 - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .2 CSA 40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

1.4 ATTACHMENTS

- .1 When attachments or anchors are required for concrete work to support vertically or laterally architectural elements, precast concrete panels, mechanical or electrical equipment, or other, manufacturer of said elements is the sole responsible for the design and calculations of attachments. The structural engineer shall not be held liable for any part of this work.
- .2 Steel plates, angles, steel rods, bolts, studs, anchoring elements or any hardware parts in direct contact with, embedded or partially embedded into concrete shall be considered attachments.

1.5 ACTIONS AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 At least 4 weeks prior to beginning work, provide Owner's Representative with test reports and certificate from independent laboratory confirming that the following materials comply with all specifications requirements :
 - .1 Grout;
 - .2 Joints gasket and any waterproofing accessory or related products;
 - .3 Joint filler.
- .3 Submit shop drawings for all steel elements embedded in concrete. When forces are induced into the concrete by embedded steel elements, provide forces and direction of forces applied to concrete works where they are embedded.
 - .1 The drawings shall bear the seal and signature of a professional engineer, certified by the Ordre des ingénieurs du Québec (OIQ).
- .4 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

- .1 Separate waste materials for reuse/recycling in accordance with Section 01 74 21 - Construction/Demolition waste management and disposal.
- .2 Place materials defined as hazardous or toxic in designated containers.
- .3 Divert wood materials from landfill to a recycling, reuse or composting facility as approved by the Representative of the Ministry.
- .4 Divert plastic materials from landfill to a recycling, reuse or composting facility as approved by the Owner's Representative.
- .5 Divert unused hazardous material from landfill to an official hazardous material collections site as approved by the Owner's Representative.

1.7 ACCEPTABLE MATERIALS

- .1 Where materials are specified by trade name refer to the Instructions to Tenderers for a procedure to be followed in applying for approval of alternatives.

2. Products

2.1 MATERIALS

.1 Sealing joints compound.

- .1 Sealing joints compound shall figure on the registered products listing from the qualification and certification program of the CGSB. When a product has been certified with a primer, this primer shall be used in conjunction with the sealing compound.
- .2 Sealing compound for dilation and control joints: polyurethane-based, chemically-cured, self-levelling two- or three-component elastometric sealant, in accordance with CAN/CGSB 19.24 and ASTM C 920 (type M, grade P or NS, class 25, use T) standards such as :
 - .1 THC 900 from Tremco Itée;
 - .2 Sikaflex 2C SL from Sika;
 - .3 MasterSeal SL 2 from BASF;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .3 Sealing compound for concrete slab joints : one-component, moisture-cured, polyurethane-based, non-sag elastometric sealant in accordance with CAN/CGSB 19.24 and ASTM C 920, (type S, grade P or NS, class 25, use T) standards such as :

- .1 Sikaflex 1a from Sika;
 - .2 Vulkem 116 from Tremco;
 - .3 Eucolastic I from Euclid;
 - .4 MasterSeal SL 1 from BASF;
 - .5 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .4 Sealing compound for vertical joints: two- or three-component, chemically-cured, polyurethane-based, elastometric sealant in accordance with CAN/CGSB 19.24 and ASTM C 920, (type M, grade NS, class 25 or 50) standards such as :
 - .1 Sikaflex 2C NS EZ MIX from Sika;
 - .2 Dymeric 240 from Tremco;
 - .3 Eucolastic II from Euclid;
 - .4 MasterSeal NP 2 from BASF;
 - .5 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .2 Waterstops.
 - .1 Ribbed, extruded PVC blade meeting the following requirements :
 - .1 Tensile resistance: according to ASTM D 412, Die « C », 11,4 MPa minimum;
 - .2 Elongation: according to ASTM D 412, Die « C », 275 % minimum;
 - .3 Tear resistance: according to ASTM D 624 Die « B » Method, 50 kN/m minimum.
 - .2 Blades shall be of sizes indicated. If no indications are given, use 150 mm wide and 10 mm thick waterstops.
 - .3 In T-, L- or X-shaped intersections use precut, prefabricated waterstops. Waterstops shall be welded together for all joints in all directions and shall be continuous everywhere (horizontally, vertically or transversally).
 - .4 Dilatation joints such as :
 - .1 Durajoint type 7C ;
 - .2 Vinylex type RLB938 ;
 - .3 Greenstreak type 718 ;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
 - .5 Construction joints such as :
 - .1 Durajoint type 4;
 - .2 Vinylex type RB6316;

- .3 Greenstreak type 779;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .3 Premoulded joint fillers :
- .1 Bituminous fiber board: according to ASTM D 1571, bituminous impregnated fiber board, premoulded and resilient. Dimensions shall be as indicated on drawings.
 - .2 Sponge rubber: according to ASTM D 1752, type I, flexible or firm.
 - .3 Standard cork: according to ASTM D 1752, type II.
 - .4 Self-expanding cork : according to ASTM D 1752, type III.
- .4 Water repellent.
- .1 Deep penetrating, 100% silane formulation that produces a hydrophobic treatment on concrete and masonry such as :
 - .1 Baracade silane 100C by Euclid;
 - .2 Sikagard SN100 by SIKA;
 - .3 MasterProtect H 1000 by BASF;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
 - .2 Emulsified asphalt, mineral-colloid type
- .5 Backer rod: closed-cell polyethylene foam, dimensions as required per drawings.
- .6 Steel for embedded steel elements: according to CSA G40.21 grade 300W or superior.
- .7 Chemical anchor system: structural epoxy resin, two-components Insensitive to external conditions.
- .8 Shrinkage compensating grout : premixed compound to ASTM C 1107/C 1107M type C, 50 MPa minimum compressive resistance after twenty-eight (28) days such as :
- .1 SikaGrout 212 by Sika;
 - .2 Dry Pact Grout by Euclid;
 - .3 In-Pakt Construction Grout or In-Pakt Construction Grout CT by KING depending on weather conditions;
 - .4 Planigrout 755 by MAPEI.
 - .5 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .9 Elastomeric joint seals for new concrete in accordance with ASTM D 2628 and supplied in one length without joints

3. Execution

3.1 ANCHOR BOLTS

- .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.
- .2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Owner Representative. Spacing between anchor bolts shall be within a 1.5 mm tolerance.
 - .1 Formed holes: 100 mm minimum diameter.
 - .2 Drilled holes: diameter to manufacturers' recommendations, 25 mm minimum larger than bolts used.
- .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
- .4 Set bolts and fill holes with shrinkage compensating grout.
- .5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

3.2 JOINT FILLERS (BACKING FOAM/BACKER ROD)

- .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Owner Representative.
- .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
- .3 Locate and form isolation, construction and expansion joints as indicated.
- .4 Use 12 mm thick joint fillers to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to within 12 mm of finished slab surface unless indicated otherwise.

3.3 JOINTS SEALING

- .1 Clean and dry joint surfaces. Cleaning shall be accomplished by mechanical means. All joint surfaces must be clean, sound, dry and frost-free. Joint walls must be free of oils, tar, asphalt, bitumen, grease, paints, coatings, sealers, curing compound residues, and any other foreign matter that might prevent adhesion.
- .2 Bond breaker tape, backing foam or backer rod must be used in bottom of joint to prevent bond. Leave free space of sufficient height to place a thickness of sealant in accordance with manufacturer's recommendations.
- .3 Before applying sealant, apply primary per manufacturer's recommendation. Clean surrounding areas after application.

3.4 WATERPROOFING FOR JOINTS

- .1 Refer to drawings to determine where joints shall be watertight. All joints below soil level shall be watertight, even if no indication is given on drawings.
- .2 Install waterstops or waterproofing joint compound to provide continuous water seal.
- .3 Do not distort, break, pierce or perforate waterstops or waterproofing joint compound in way as to hamper performance.
- .4 Do not displace reinforcement when installing waterstops.
- .5 Use equipment to manufacturer's requirements to field splice waterstops.
- .6 Tie waterstops rigidly in place.
- .7 Use only straight heat sealed butt joints in field.
- .8 Use factory welded corners and intersections unless otherwise approved by Owner Representative.

3.5 EMBEDDED STEEL

- .1 Fabrication of embedded steel elements according to CSA S16.
- .2 Ensure galvanic separation (galvanization, neoprene or other) between any steel and aluminium element.

3.6 APPLICATION – SEALER FOR CONCRETE SURFACES (WATER REPELLENT)

- .1 Apply a water repellent on all concrete surfaces that may be or are in contact with water, including concrete exposed to weather conditions.
- .2 Concrete shall be cured for twenty-eight (28) days prior to waterproofing surfaces.
- .3 Surfaces shall be clean and dry before applying water repellent. Between twenty-four (24) and seventy-two (72) hours prior to application, surfaces shall be cleaned using a high-pressure (5 000 lb.) water jet to eliminate any residue (coating, laitance, oil, dirt or other) on concrete.
- .4 Air, material and surface temperatures shall be 5 °C or higher during application. Do not apply sealer when temperature is expected to drop under 0 °C within twelve (12) hours.
- .5 Cover or protect with drop cloth nearby shrubbery, landscaping, pavement or other.
- .6 Apply sealer at a maximum rate of 4.3 m²/l. Submit method of application and method of control to the Owner Representative. Follow manufacturer's recommendations, especially when rate of application need be reduced in presence of porous concrete.

- .7 Sealed surface shall be protected against rain and any splashing at least six (6) hours following treatment.

END OF SECTION

1. General

1.1 RELATED REQUIREMENTS

- .1 Section 03 11 00 – Concrete Forming.
- .2 Section 03 15 00 – Concrete Accessories.
- .3 Section 03 30 00 – Cast-in-Place Concrete.
- .4 Section 03 35 00 – Concrete Finishing.
- .5 Section 03 39 00 – Concrete Curing.

1.2 PRICING AND PAYMENT PROCEDURE

- .1 Measure reinforcing steel in kilograms of steel incorporated into Work, computed from theoretical unit mass specified in CSA G30.18 for lengths and sizes of bars as indicated or authorized in writing by the Representative of the Ministry.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A 82/A 82M-07, Standard Specification for Steel Wire Plain, for Concrete Reinforcement.
 - .2 ASTM A 143/A 143M-07(2014), Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .3 ASTM A 185/A 185M-07, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - .4 ASTM A 496/A 496M-07, Standard Specification for Steel Wire Deformed, for Concrete Reinforcement.
 - .5 ASTM A 497/A 497M-07, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - .6 ASTM A 641/A 641M-09a(2014), Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .7 ASTM A 706/A 706M-14, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 - .8 ASTM A 722/A 722M-12, Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
 - .9 ASTM A 767/A 767M-09, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - .10 ASTM A 775/A 775M-14, Standard Specification for Epoxy-Coated Steel Reinforcement Bars.

- .11 ASTM A 780/A 780M-09, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- .12 ASTM A 1035/A 1035M-11, Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement.
- .13 ASTM A 1044/A 1044M-05(2010), Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete.
- .2 Canadian Standard Association (CSA)/CSA International.
 - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete;
 - .2 CSA A23.3-14, Design of Concrete Structures;
 - .3 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement;
 - .4 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CSA W186-M1990(R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .3 Reinforcing Steel Institute of Canada (RSIC).
 - .1 RSIC-2006, Reinforcing Steel Manual of Standard Practice.

1.4 ACTIONS AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315 standard.
- .3 Submit shop drawings. Indicate placing of reinforcement and:
 - .1 Bar bending details.
 - .2 Lists of reinforcing elements.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by the Representative of the Ministry, with identifying code marks to permit correct placement without reference to structural drawings.
 - .5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
- .4 Submit, in conjunction with shop drawings, lists of steel reinforcing elements corresponding to shop drawings.
- .5 Verify on field all dimensions and levels not defined on drawings or that may depend on field conditions.
- .6 The Representative of the Ministry may take up to ten (10) working days to verify and return shop drawings.

- .7 Corrections and comments made on shop drawings during the revision process do not limit the Contractor responsibility to respect requirements of drawings and specifications. Review of shop drawings is done only to ensure the general conformity in regard to design and contract requirements. Contractor shall confirm and correlate all dimensions and characteristics, choose method of fabrication and construction and execute work safely.
- .8 If revision required on shop drawings are too numerous or too important, the Representative of the Ministry will return drawings without annotations, awaiting a new submittal. If drawings are submitted more than two times, the Contractor shall pay, by mean of a permanent deduction, the cost of review.
- .9 Work shall not begin before shop drawings have been reviewed by the Representative of the Ministry.
- .10 The Contractor assumes full responsibility for the exactness of his drawings. He may not claim any extra charge for delays resulting from the discovery, be it on the field or before, of mistakes on his drawings, even if they were examined by the Representative of the Ministry.

1.5 REBAR DETAILLING

- .1 In general, use details in accordance with RSIC *Reinforcing Steel Manual of Standard Practice*.
- .2 Unless otherwise indicated, development lengths and cover shall be in accordance with articles 7 and 12 of CAN/CSA A23.3 standard.
- .3 Detail lap lengths and bar development lengths as type B tension lap splices unless otherwise indicated. Refer to *RSIC Reinforcing Steel Manual of Standard Practice*, table 17B, for lap lengths.
- .4 Dimensions of ties, spiral reinforcing, hangers and stirrups shall be determined in accordance with minimum concrete cover from article 6.6.6 of CSA A23.1 standard.
- .5 Unless otherwise indicated, hooks required, including stirrups and ties, shall be standard hooks as defined in article 6.6.2.2 of CSA A23.1 standard.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal :
 - .1 Separate waste materials for reuse/recycling in accordance with Section 01 74 21 - Construction/Demolition waste management and disposal.
 - .2 Place materials defined as hazardous or toxic in designated containers.
 - .3 Divert wood materials from landfill to a recycling, reuse or composting facility as approved by the Representative of the Ministry.
 - .4 Divert plastic materials from landfill to a recycling, reuse or composting facility as approved by the Representative of the Ministry.

- .5 Divert unused hazardous material from landfill to an official hazardous material collections site.

1.7 ACCEPTABLE MATERIALS

- .1 Where materials are specified by trade name refer to the Instructions to Tenderers for a procedure to be followed in applying for approval of alternatives

2. Products

2.1 MATERIALS

- .1 Substitute different size bars only if permitted in writing by the Representative of the Ministry.
- .2 Reinforcing steel: unless otherwise indicated, billet bars, according to CSA G30.18 grade 400W, or ASTM A 706/A 706M, grade 60.
- .3 Low-carbon steel bars: according to ASTM A 1035/A 1035M.
- .4 High strength steel bars: according to ASTM A 722/A 722M.
- .5 Galvanized steel bars: according to ASTM A 767/A 767M, class I or II.
- .6 Plain steel wire for concrete reinforcement: cold-drawn steel wire, as-drawn or galvanized, for the reinforcement of concrete, according to ASTM A 82/A 82M.
- .7 Deformed steel wire for concrete reinforcement: cold-worked by drawing, rolling, or both drawing and rolling, steel wire for the reinforcement of concrete according to ASTM A 496/A 496M.
- .8 Steel welded wire reinforcement: welded wire reinforcement (mesh), according to ASTM A 185/A 185M.
 - .1 Provide in flat sheets only.
- .9 Steel welded wire reinforcement, high adherence: welded wire reinforcement (mesh) made from cold-worked drawn or rolled deformed wire, or a combination of deformed and non-deformed wires, to be used for the reinforcement of concrete, to ASTM A 497/A 497M.
 - .1 Provide in flat sheets only.
- .10 Galvanized carbon steel wire: according to ASTM A 641/A 641M.
- .11 Epoxy Coating of non-prestressed reinforcement: according to ASTM A 775/A 775M.

- .12 Galvanizing of non-prestressed reinforcement: according to ASTM A767/A 767M class I or II, minimum zinc coating 610 g/m².
 - .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
 - .2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.
 - .3 Temperature of solution equals to or greater than 32 degrees and galvanized steels immersed for minimum of twenty (20) seconds.
 - .4 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
 - .1 In this case, no restriction applies to temperature of solution.
 - .5 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.
 - .1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .13 Chairs, bolsters, bar supports, spacers: according to CSA-A23.1/A23.2.
- .14 Plain round bars: according to CSA-G40.20/G40.21.
- .15 Zinc-rich coating:
 - .1 Use zinc-rich coating according to CAN/CGSB 1.181 and ASTM A 780/A 780M containing at least 92% of metallic zinc in dried coat, brush applied.
 - .2 Approved products:
 - .1 Zinc-paste 70-40 by Metaflux;
 - .2 ZRC Galvilite by Meta-Plus.
 - .3 Rust-anode by Galvatech (distributor).
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with CSA A23.1, ACI 315 standards and RSIC Reinforcing Steel Manual of Standard Practice.
- .2 Fabrication tolerances shall be in accordance with RSIC manual chapter 6 or the following paragraphs, as determined by the more stringent requirement. Bars fabricated without conforming to those tolerances will be rejected.
- .3 Tolerance for cutting rebar.
 - .1 10M and 15M rebar:

- .1 Less than 4.0 meters long: ± 12 mm;
 - .2 4.0 meters or more: ± 25 mm.
- .2 20M to 35M rebar: ± 25 mm.
- .3 45M and 55M: ± 25 mm.
- .4 Tolerance for bent rebars.
 - .1 10M to 35M rebar :
 - .1 Overall length: ± 25 mm;
 - .2 Overall height: ± 12 mm;
 - .3 Hook diameter: ± 12 mm.
 - .2 Ties and stirrups :
 - .1 Overall width and length: ± 12 mm.
- .5 Obtain the Representative of the Ministry written approval for locations of reinforcement splices other than those shown on placing drawings.
- .6 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.
- .7 Ship epoxy coated bars in accordance with ASTM A 775A/A 775M.
- .8 Galvanized bars shall be bent after galvanizing.
 - .1 After the bar is bent, minor peeling of coating is considered acceptable. A value of surface peeling up to the bar nominal section area is considered acceptable. For surface peeling higher than the nominal section area, bar will be rejected and need to be replaced.
- .9 All reinforcing steel shall be bent to be parallel to the edge of concrete works, as indicated on drawings. Bending shall be done in shop, as indicated on shop drawings.

2.3 SOURCE QUALITY CONTROL

- .1 Upon request, provide the Representative of the Ministry with certified copy of mill test report of reinforcing steel, minimum two (2) weeks prior to beginning reinforcing work. Test reports shall indicate physical and chemical properties of steel.
- .2 Upon request, submit in writing to the Representative of the Ministry, proposed source of reinforcement material to be supplied.
- .3 Identify bundles of bar reinforcement and wire mesh, in accordance with shop drawings, bar bending details and lists before shipping.
- .4 All rebars shall be identified during fabrication. Identification shall include diameter, grade and fabricator. Rebar not properly identified will not be allowed on site.

2.4 STORAGE

- .1 Store materials off ground over wood studs or indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area to prevent rusting.
- .2 Protect reinforcing steel if stored over a long period.
- .3 Replace defective or damaged materials with new.

3. Execution

3.1 PREPARATION

- .1 Galvanizing to include chromate treatment.
 - .1 Duration of treatment: 1 hour per 25 mm of bar diameter.
- .2 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A 143/A 143M.

3.2 FIELD BENDING

- .1 Do not field bend or field weld reinforcement except for a written approval by the Representative of the Ministry.
- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars which develop cracks or splits.
- .4 Unless otherwise indicated, field weld reinforcement is prohibited. When authorized, weld specially identified rebars.

3.3 PLACING REINFORCEMENT

- .1 Clean reinforcing steel before placement. Steel shall be free from mud, oil, or other coatings that adversely affect bond strength. Bar surface shall be in accordance to CSA A23.1 article 6.1.6.
 - .2 Place reinforcing steel as indicated on placing drawings and in accordance with CSA A23.1. Refer to article 6.6.7 of this standard for placement and number of supports.
 - .3 Attach reinforcing steel solidly to supports to prevent any movement during concreting.
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- .4 Support bars are not included on drawings. Use 15M reinforcing bar spaced at 1 000 mm on center to support top reinforcing steel.
- .5 When concrete will never be exposed to weather conditions, use chairs and hangers with nylon- or plastic-covered extremities.
- .6 When concrete will be exposed to weather conditions or sandblasted, use chairs and hangers with nylon- -covered extremities or fabricated with stainless steel.
- .7 For slab-on-grade and footings, reinforcing steel is placed on chairs, supports and/or cement brick, spaced on center 1 000 mm maximum.
- .8 Rocks, piece of rocks, woods or pipes shall not be used to support reinforcing steel.
- .9 Lifting the reinforcing steel with a hook at the time of concreting is prohibited.
- .10 Overlap wire mesh by 150 mm minimum, unless otherwise indicated.
- .11 Install dowels and anchors for walls and columns with template before concreting. Spacing of anchors shall be within 1.5 mm of dimensions indicated on drawings.
- .12 Use plain round bars as slip dowels in concrete, unless otherwise indicated in drawings.
 - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
 - .2 When paint is dry, apply thick even film of mineral lubricating grease.
- .13 At least forty-eight (48) hours prior to placing concrete, obtain the Representative of the Ministry approval of reinforcing material and placement.
- .14 Ensure cover to reinforcement is maintained during concrete pour.
- .15 During concreting, a worker shall be assigned to replacing reinforcing steel that may have been displaced during the operation.
- .16 Drill holes into concrete, place adhesive and anchor steel into existing concrete per manufacturer's recommendations.
- .17 Protect reinforcement coating during concreting.
- .18 Protect epoxy and paint coated portions of bars with covering during transportation and handling.

3.4 CONCRETE COVER

- .1 Unless otherwise indicated, cover thickness for reinforcement in concrete, shall be :
 - .1 Concrete over ground forms, in permanent contact with soil: 75 mm.
 - .2 Concrete exposed to soil or weather conditions :

Beams and Columns	
35M and smaller rebar	50 mm
Ties, hangers, stirrups	40 mm
Slabs, Walls and Joists	
25M to 55M rebar	2,0*d _b or 60 mm, smallest value
20M and smaller rebar	40 mm

d_b: nominal bar diameter.

- .3 Interior concrete not exposed to soil or weather conditions :

Beams and Columns	
45M and 55M rebar	d _b
35M and smaller rebar	40 mm
Ties, hangers, stirrups	30 mm
Slabs, Walls and Joists	
25M to 55M rebar	1,0*d _b
20M and smaller rebar	20 mm

d_b: nominal bar diameter.

- .4 Concrete exposed to chlorides: 60 mm.

3.5 FIELD TOUCH-UP

- .1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.
- .1 For galvanized steel, use zinc-rich coating to article 2.1.15.

3.6 WELDING

- .1 Unless written approval, do not weld reinforcement.
- .2 When welded splice are specified and location has been approved by the Representative of the Ministry, weld reinforcement in accordance with CSA W186 and article 6.6.10 of CSA A23.1 standard. Weldable (W) grade reinforcement shall be used.

- .3 Welding shall be done by contractor certified by the Canadian Welding Bureau.

END OF SECTION

1. Generals

1.1 RELATED REQUIREMENTS

- .1 Section 03 11 00 – Concrete Forming.
- .2 Section 03 15 00 – Concrete Accessories.
- .3 Section 03 20 00 – Concrete Reinforcing.
- .4 Section 03 35 00 – Concrete Finishing.
- .5 Section 03 39 00 – Concrete Curing.

1.2 PRICING AND PAYMENT PROCEDURE

- .1 No measurement will be made under this Section. Present a lump sum price for Cast-in Place Concrete.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A 820/A 820M-11, Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.
 - .2 ASTM C 31/C 31M-12, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - .3 ASTM C 33/C 33M-13, Standard Specification for Concrete Aggregates.
 - .4 ASTM C 39/C 39M-14a, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - .5 ASTM C 42/C 42M-13, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - .6 ASTM C 88-13, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - .7 ASTM C 109/C 109M-13, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
 - .8 ASTM C 143/C 143M-12, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - .9 ASTM C 260-10a, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .10 ASTM C 330/C 330M-14, Standard Specification for Lightweight Aggregates for Structural Concrete.
 - .11 ASTM C 457/C 457M-12, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete

- .12 ASTM C 494/C 494M-13, Standard Specification for Chemical Admixtures for Concrete.
- .13 ASTM C 535-12, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- .14 ASTM C 618-12a, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- .15 ASTM C 873/C 873M-10a, Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds.
- .16 ASTM C 989/C 989M-13, Standard Specification for Slag Cement for Use in Concrete and Mortars.
- .17 ASTM C 1017/C 1017M-13, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
- .18 ASTM C 1116/C 1116M-10a, Standard Specification for Fiber-Reinforced Concrete.
- .19 ASTM C 1157/C 1157M-11, Standard Performance Specification for Hydraulic Cement.
- .20 ASTM C 1202-12, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- .21 ASTM C 1240-12, Standard Specification for Silica Fume Used in Cementitious Mixtures.
- .22 ASTM C 1609/C 1609M-12M, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).
- .23 ASTM C 1611/C 1611M-14, Standard Test Method for Slump Flow of Self-Consolidating Concrete.
- .2 Canadian Standard Association (CSA)/CSA International.
 - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA A23.3-14, Design of Concrete Structures.
 - .3 CSA A283-06(R2011), Qualification Code for Concrete Testing Laboratories.
 - .4 CSA A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .1 CSA A3001-13, Cementitious materials for use in concrete.
- .3 International Concrete Repair Institute (ICRI).
 - .1 Guideline No. 310.1R-2008, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
 - .2 Guideline No. 320.1R-1996, Guide for Selecting Application Methods for the Repair of Concrete Surfaces.

- .3 Guideline No. 320.2R-2009, Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces.

1.4 DESIGN CRITERIA

- .1 Performance: according to CSA A23.1, and as described in MIXES of PART 2 - PRODUCTS.

1.5 ACTIONS AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit Material Safety Data Sheets (MSDS) in accordance with the Workplace Hazardous Materials Information System (WHMIS).
- .3 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets. Minimum four (4) weeks prior to starting concrete work, submit to the Representative of the Ministry test reports and certificate from testing laboratory certifying that the following materials meet the requirements of this section:
 - .1 Portland cement,
 - .2 Supplementary cementing material,
 - .3 Admixtures,
 - .4 Aggregates,
 - .5 Water.
- .4 Provide the Representative of the Ministry, minimum fourteen (14) days prior to starting concrete work, with valid and recognized certificate from plant delivering concrete. Certificate shall indicate that plant, materials and methods used in fabricating concrete are in accordance with CSA A23.1 standard.
 - .1 If plant does not have a valid certificate, submit test data and certificate from independent testing laboratory certifying that concrete mix materials meet the requirements of this section.
- .5 Minimum fourteen (14) days prior to starting concrete work, provide proposed quality control procedures for review by the Representative of the Ministry on following items:
 - .1 Falsework erection.
 - .2 Hot weather concrete.
 - .3 Cold weather concrete.
 - .4 Curing.
 - .5 Finishes.
 - .6 Formwork removal.
 - .7 Joints.

Minimum fourteen (14) days prior to starting concrete work, provide the Representative of the Ministry with concrete mix formulas including admixtures for this project. Concrete formulas will be submitted to testing laboratory for approval prior to beginning work.

- .6 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet the specified resistance.
- .7 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with section 01 45 00 - Quality Control.
- .2 Pre-installation Meetings: in accordance with section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart. Convene pre-installation meeting one week prior to beginning concrete works.
 - .1 Ensure key personnel, site supervisor, the Representative of the Ministry, speciality contractor - finishing, forming, concrete producer and testing laboratories attend.
 - .2 Verify project requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Concrete hauling time: deliver to site of work and discharged within one hundred and twenty (120) minutes maximum after batching.
 - .1 Do not modify maximum time limit without receipt of prior written agreement from the Representative of the Ministry and concrete producer as described in CSA A23.1.
 - .2 Deviations to be submitted for review by the Representative of the Ministry.
- .2 Deliver concrete using means to prevent separation of concrete mix component or any alteration to consistency.
- .3 Waste Management and Disposal :
 - .1 Separate waste materials for reuse/recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Divert unused concrete and concrete materials to local quarry after receipt of written approval from the Representative of the Ministry.
 - .3 Provide on-site adequate space for the safe washing of concrete trucks.
 - .4 Divert unused admixtures from landfill to an official hazardous material collections site.

- .5 Do not dispose of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.
- .6 Prevent admixtures and additive materials from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with inert, non-combustible material and remove for disposal. Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

1.8 ACCEPTABLE MATERIALS

- .1 Where materials are specified by trade name refer to the Instructions to Tenderers for a procedure to be followed in applying for approval of alternatives

2. Products

2.1 MATERIALS

- .1 Portland Cement: according to CSA A3001, type GU, unless otherwise indicated.
- .2 Supplementary cementing materials: according to CSA A3001.
 - .1 Maximum total supplementary cementing materials mass inferior to 25% of total cementitious materials.
 - .2 Fly ash and natural pozzolan: according to ASTM C 618.
 - .3 Ground granulated blast-furnace slag: according to ASTM C 989/C 989M.
 - .4 Silica fume: according to ASTM C 1240.
- .3 Water: according to CSA A23.1, article 4.2.2.
- .4 Non-reactive to alkalis aggregates: according to CSA A23.1, article 4.2.3 and ASTM C 33/C 33M, normal weight coarse aggregate.
 - .1 The particles must be clean, durable, without dust or deleterious materials, containing less than 25% of flat or elongated particles, as determined by testing according to CSA A23.2-13A.
 - .2 Loss by abrasion (according to ASTM C 535, CSA A23.2-16A) shall be less than 50%. Loss shall be less than 12% after five (5) cycles of testing soundness by use of sodium sulfate or magnesium sulfate (ASTM C 88, CSA A23.2-9A).
 - .3 Aggregates should not be made of fine-grained limestone and crystalline limestone.
 - .4 The use of potentially reactive aggregates will be permitted only if compensatory measures as defined in CSA A23.2-27A are used. The use of

a mixture containing potentially reactive aggregates is subject to the written approval of the Representative of the Ministry, under favorable opinion of the laboratory responsible for the quality control of materials.

- .5 Fine aggregates (sand): according to CSA A23.1, article 4.2.3 and ASTM C 33/C 33M, normal weight.
- .6 Lightweight aggregates: according to ASTM C 330/C 330M.
- .7 Recycled aggregates: according to NQ 2560-600.
- .8 Admixtures:
 - .1 Air entraining admixture: according to ASTM C 260.
 - .2 Chemical admixture: according to ASTM C 494/C 494M or ASTM C 1017/C 1017M when added to flowing concrete. The Representative of the Ministry to approve accelerating or set retarding admixtures during cold and hot weather placing.
 - .3 Anti-washout admixture such as :
 - .1 Eucon AWA by Euclid ;
 - .2 MasterMatrix UW450 by BASF ;
 - .3 Sika Stabilizer Aquagel by Sika ;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .9 Evaporation retardant: such as :
 - .1 MasterKure ER 50 by BASF ;
 - .2 Eucobar by Euclid ;
 - .3 Evapre by W.R. Meadows ;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.

2.2 MIXES

- .1 Provide concrete to meet content and performance requirements defined by the Representative of the Ministry in accordance with CSA A23.1 on following articles. Refer to table 1 and table 2 of CSA A23.1 for requirements related to exposition class.
- .2 Ensure that concrete supplier meet component and performance requirements identified hereafter and control compliance as indicated in article FIELD QUALITY CONTROL or PART 3.
- .3 Concrete mix used for **all concrete works, unless otherwise indicated**, shall meet the following requirements:
 - .1 Cement : Portland cement type GUB-SF (10-SF);

- .2 Nominal size of coarse aggregate: 20 to 40 mm;
 - .3 Slump at discharge: 80 ± 30 mm;
 - .4 Air content: 5 to 8 %;
 - .5 Exposition class: C-1;
 - .6 Ion chloride permeability : less than 1 500 coulombs,
 - .7 Minimum compressive strength: 35 MPa at twenty-eight (28) days.
 - .8 Minimum flexural strength: 3 MPa at twenty-eight (28) days.
- .4 Concrete mix used for **self-consolidating concrete used in new construction**
Concrete mix used for **lean concrete** shall meet the following requirements:
- .1 Cement : Portland cement type GU (10);
 - .2 Nominal size of coarse aggregate: 20 mm;
 - .3 Slump at discharge: 80 ± 30 mm;
 - .4 Air content: 5 to 8 %;
 - .5 Exposition class: N;
 - .6 Minimum compressive strength: 15 MPa at twenty-eight (28) days.
- .5 Refer to the table at the end of this section for a summary of concrete mix requirements.
- .6 Concrete supplier and Contractor shall ensure that all concrete meet the following requirements:
- .1 Unless otherwise indicated, aggregates shall be of normal weight.
 - .2 For all parts of work, concrete mix shall be homogeneous and when cured, have the strength, resistance to deterioration, durability, appearance and other properties required by this specification.
 - .3 Mix design shall ensure durability, strength, workability and other properties required for concrete.
 - .4 Mix shall ensure that concrete flows everywhere into formworks, wrap up reinforcing bars completely but without allowing segregation of materials or excessive bleeding
 - .5 Concrete shall be free from surface blemishes, loss of mortar or color variations.
- .7 For floors with a trowel finish, Concrete Provider and General Contractor shall ensure that concrete mix is appropriate to obtain the level of quality desired for the slab finish.
- .1 Use a concrete mix having a minimum compressive strength of 25 MPa and a maximum water-to-cementitious ratio of 0.55, as specified for class N-CF concrete.
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- .2 For slab poured directly on a vapour retarding membrane, use a maximum water-to-cementitious ratio of 0.45 or less. If using a mix with a ratio higher than 0.45, the Contractor shall allow for a longer drying period for the slab to obtain the relative humidity appropriate to place floor covering.
- .3 To ensure proper placement and finishing, consider using superplasticizer. Initial concrete slump should be near 60 mm and final slump should reach near 130 mm following addition of superplasticizer.
- .8 For slabs on ground screeded by machine, 40 mm blended coarse aggregates may be used.
- .9 When concrete thickness is less than 200 mm, maximum size of coarse aggregate shall be 14 mm.

2.3 SPECIAL REQUIREMENTS

- .1 Use of admixtures.
 - .1 Provide samples of admixtures by the Representative of the Ministry's request.
 - .2 Follow manufacturer's recommendations for admixtures use.
 - .3 Ensure compatibility of admixtures, between them and with all components of concrete mix.
 - .4 Use of admixture shall never affect adversely concrete durability including resistance under freeze-thaw cycles.
- .2 Internal vibrators shall be used for consolidating concrete.
- .3 Do not modify concrete mix formulas without the Representative of the Ministry approval. If source of supply for concrete materials is modified, new concrete mix formulas need be approved by the Representative of the Ministry.
- .4 Unless written authorization is given by the Representative of the Ministry, no water shall be added into concrete mix during transport or after arrival on work site.

2.4 METHODS OF TEST FOR CONCRETE

- .1 Reference values indicated in this section shall be obtained from tests in accordance with standards indicated in the following table:

Tests	Standard
Air content	ASTM C 457/C 457M, CSA A23.2-4C
Compressive strength of 50 mm cube specimens	ASTM C 109/C 109M

Compressive strength of concrete cylinders	ASTM C 873/C 873M, CSA A23.2-9C
Degradation of coarse aggregates	ASTM C 535, CSA A23.2-16A
Degradation of fine aggregates	ASTM C 88, CSA A23.2-9A
Flat and elongated particles in coarse aggregate	CSA A23.2-13A
Ion chloride permeability	ASTM C 1202
Obtaining and curing concrete test specimens	CSA A23.2-3C
Obtaining and testing drilled cores of concrete (compressive resistance)	ASTM C 42/C 42M, ASTM C 39/C 39M, CSA A23.2-14A
Obtaining concrete test specimens	ASTM C 31/C 31M, CSA A23.2-1C
Slump	ASTM C 143/C 143M, CSA A23.2-5C
Slump-flow (self-consolidating concrete)	ASTM C 1611/C 1611M, CSA A23.2-5C

- .2 Tests shall be carried out by an independent testing laboratory.

3. Execution

3.1 PREPARATION

- .1 Place formworks in accordance with section 03 11 00 – Concrete Forming. Place embedded elements and concrete reinforcing in accordance with sections 03 15 00 – Concrete Accessories and 03 20 00 - Concrete Reinforcing.
- .2 Obtain the Representative of the Ministry's approval before placing concrete.
 - .1 Provide forty-eight (48) hours minimum notice prior to placing of concrete.
- .3 During concreting operations:
 - .1 Development of cold joints is not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.

- .3 Placing of concrete shall be done in accordance with article 7.4 of CSA A23.1 standard.
- .4 Pumping of concrete is permitted only after approval of equipment and mix, conditional to execution in accordance with testing laboratory recommendations.
- .5 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .6 Prior to placing concrete, formworks shall be cleaned and free of water.
- .7 Prior to placing of concrete, obtain the Representative of the Ministry's approval of proposed method for protection of concrete during placing and curing.
- .8 Approval is given before concreting, conditional to:
 - .1 Previous approval of formworks and concrete reinforcing after inspection by the Representative of the Ministry.
 - .2 Favorable climatic conditions, namely an external temperature between 5 and 25°C and the absence of rain or snow, unless the Representative of the Ministry has approved arrangements (shelter, heating, etc.) previously.
- .9 Protect previous work from staining.
- .10 Take special precautions where concrete will be exposed to prevent any damage.
- .11 Clean and remove stains prior to application for concrete finishes.
- .12 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken. Submit concrete works registry at the end of each phase of work.
- .13 In locations where new concrete is dowelled to existing work, drill holes in existing concrete, 300 mm deep minimum, unless otherwise indicated.
 - .1 Place steel dowels of 20M 400W steel reinforcing bars and pack solidly with adhesive to anchor and hold dowels in positions as indicated.
 - .2 Unless otherwise indicated, use epoxy adhesive.
- .14 Do not place load upon new concrete until authorized by the Representative of the Ministry.

3.2 PRODUCTION OF CONCRETE

- .1 Provide ready-mixed concrete, fabricated in concrete plant, delivered and offloaded to site in accordance to section 5.2 of CSA A23.1 standard. Alternatively, provide concrete fabricated on site in accordance to the same section. When concrete is fabricated on site, submit methods and equipment for approval by the Representative of the Ministry.

- .2 Producer of ready-mixed concrete is the sole responsible for formulation of concrete. Producer shall take all steps required to ensure production of high quality, uniform concrete.
- .3 Request from concrete provider delivery slip for each delivery of concrete and hand over one copy to the Representative of the Ministry. Delivery slip shall include: name and address of the batch plant, truck number, name of Contractor, designation of the job (name and location), class or designation of the concrete, amount of concrete delivered and cumulative amount, time of loading, of beginning of unloading and of end of unloading, maximum size of coarse aggregate, slump and air content required, admixtures used, amount and type of cement and water quantity.
- .4 **Adding water after initial batching at concrete plant is prohibited**, notwithstanding any indications given in article 5.2.5.3.2 of CSA A23.1 standard. Use water-reducing admixture to ASTM C 494, type F or G, to correct concrete's slump.
- .5 Plan fabrication of concrete and spread deliveries to site to ensure that pouring is continuous.
- .6 Never again batch concrete or mortar after beginning of hardening.
- .7 Concrete temperature at discharge shall be within limits of table 14 of CSA A23.1, tested to article 5.2.5.4 of the same standard. Use protective measures whenever necessary.

3.3 INSTALLATION / APPLICATION

- .1 Execute cast-in-place concrete work to CSA A23.1.
- .2 Saturate with water hardened concrete surfaces where new concrete will be placed.
- .3 Bond fresh concrete to rock or hardened concrete to CSA A23.1 article 7.8.5.
- .4 Concrete shall look good, be free from honeycomb, cold joints, burrs or other defects.
- .5 Wherever concrete will be exposed, take special precautions in placing concrete and in using good quality brand-new formworks.
- .6 Ensure no shocks or impacts occur on formworks and on freshly poured concrete.
- .7 Deposit concrete in horizontal layers, 500 mm thick maximum, as near as possible to its final position.
- .8 The Contractor is the sole responsible for choosing free-drop height of concrete as to obtain a high-quality work. In general, free-drop shall not exceed 1.5 m to prevent segregation. Use chutes, slides and/or trunks whenever necessary.

- .9 For placing concrete for any concrete element, specifically columns, shear walls and any element with significant reinforcing quantity, use superplasticizer admixture to facilitate placing.
- .10 Internal vibrators shall be used for consolidating concrete. Vibrators shall be applied at such spacing intervals as to compact all concrete properly. Do not vibrate excessively as to prevent segregation. Do not use vibration to force concrete horizontally in place. Follow requirements of CSA A23.1 article 7.4.4.2 and ACI 309R for consolidating concrete.
- .11 Do not place concrete in water unless special authorization is given. Follow the the Representative of the Ministry and testing laboratory instructions strictly. If a special authorization is given for placing concrete in water, use an anti-washout admixture.
- .12 Under adverse weather or if equipment failure occurs, take measures to prevent deterioration of freshly poured concrete. When discontinuing work, prepare construction joints and protect fresh concrete with membranes.
- .13 If Contractor does not use shores, the Representative of the Ministry may request that the Contractor demonstrates, by mean of a letter signed by an engineer member of the Ordre des ingénieurs du Québec (OIQ), that shores are not required for that part of works.
- .14 For placing concrete for slabs, follow the requirements of ACI 302.1R standard.
- .15 Place grout under machinery bases and pedestals, per manufacturer's recommendations, to obtain a bearing surface of 100% of the area covered by grout.

3.4 HOT-WEATHER CONCRETING

- .1 Hot-weather concreting shall be done in accordance to CSA A23.1, article 7.1.1 and ACI 305R. Submit, for approval by the Representative of the Ministry, hot-weather concreting procedure prior to beginning works.
- .2 The Contractor shall protect in-place concrete against the effects of heat and dry weather. During very hot periods, the Contractor must protect formworks, reinforcement and concreting equipment against the direct rays of the sun or cool them by spraying water.
- .3 When outside temperature is 25°C or more, or when the Representative of the Ministry judges that the temperature may rise to 25°C or more during concreting, use special precautions to maintain concrete temperature as low as practicable, and never higher than 30°C when minimum dimension of concrete element is smaller than 1 m, 25°C when this dimension is between 1 and 2 m and 20°C for elements larger than 2 m.

3.5 PROTECTION AGAINST DRYING

- .1 During placement of concrete, Contractor shall estimate the rate of superficial moisture evaporation using figure D.1 of CSA A23.1 standard. When the rate is higher than $0.50 \text{ kg}/(\text{m}^2 \cdot \text{h})$, the Contractor shall use the supplementary measures defined by article 7.1.1 of CSA A23.1, such as:
 - .1 Wet support before placing concrete.
 - .2 Lower concrete temperature.
 - .3 Cover concrete surface prior to and between different steps when finishing concrete.
 - .4 Vaporize water (use fogging) continuously after concrete placement, taking care that ponding does not occur.
 - .5 Start curing immediately after final finishing; or
 - .6 Place and finish concrete by night or early in the morning.
- .2 In addition to measures defined in article 3.5.1, the Contractor may use an evaporation retardant to article 2.1.14 as a supplementary measure. The evaporation retardant shall be used immediately following concrete placement, following the manufacturer's recommendations. Depending on climatic conditions, many successive applications may be required.
- .3 The Representative of the Ministry or the representative from the testing laboratory may require the use of the supplementary measures listed above if the Contractor is not able to demonstrate that the rate of superficial moisture evaporation is lower than $0.50 \text{ kg}/(\text{m}^2 \cdot \text{h})$.

3.6 COLD-WEATHER CONCRETING

- .1 Cold-weather concreting shall be done in accordance with CSA A23.1, article 7.1.2 and ACI 306R. Submit, for approval by the Representative of the Ministry, cold-weather concreting procedure prior to beginning works.
- .2 Before placing concrete under cold-weather conditions, all equipment needed to protect concrete shall be available on site of works.
- .3 Obtain approval from the Representative of the Ministry before pouring concrete when exterior temperature is below 5°C .
- .4 When outside temperature is 5°C or below, or when the Representative of the Ministry judges that temperature may fall below 5°C during concreting, ensure that concrete temperature remains above 16°C , and never higher than 32°C . Heat water and aggregates if necessary before mixing.
- .5 When concreting is not done under heated enclosures, the Representative of the Ministry may stop concreting if temperature drops to -10°C or below or if winds or snow affects adversely concreting.

- .6 Before concreting, inner walls, reinforcing bars and bottom of formworks shall be cleaned free of snow or ice. Heat formwork and reinforcing bars if necessary. No concrete shall be poured where surfaces or reinforcing bars temperature is below 5°C.
- .7 After concreting, maintain surface temperature of concrete at 21°C for a minimum of three (3) days or 10°C for a minimum of seven (7) days. Concrete temperature shall remain over freezing point for a minimum of seven (7) days and concrete shall not be exposed under freeze-thaw cycles for a minimum of fourteen (14) days.
- .8 Use of calcium chloride, other de-icing salts or chemical products as substitute to proper curing and protection methods is prohibited.
- .9 After protection, concrete temperature shall be lowered progressively, up to a maximum of 6°C per day, until concrete reaches the outside temperature.
- .10 If heated enclosures are used, the Contractor shall, if necessary, moisten air to maintain concrete and formwork moist. Stationary heaters can be used as long as concrete surfaces will not be exposed to heating gases resulting from combustion.
- .11 Costs for cold-weather concreting are included in pricing defined in item 1.2 Pricing and Payment Procedure.

3.7 CONSTRUCTION JOINTS

- .1 Refer to CSA A23.1, article 7.2 for construction joints.
- .2 When concrete works are of a volume or complexity such that placing cannot be done in one operation, the Contractor shall, pending approval of the Representative of the Ministry, add construction joints even where there is no indication on drawings. Costs for materials and handiwork required to execute construction joints shall be assumed by the Contractor.
- .3 The Contractor shall submit a drawing with location and details for construction joints to the Representative of the Ministry, whom may take up to two (2) weeks before approving said drawing.
- .4 For vertical elements (walls, continuous footings), place construction joints at 20 m center-to-center maximum.
- .5 Construction joints indicated on drawings are mandatory and shall not be moved.
- .6 Before placing new concrete, Contractor shall prepare joint in accordance with the following requirements:
 - .1 Tighten formworks at joint,
 - .2 Clean thoroughly hardened concrete to obtain a surface free of foreign matter, laitance, damaged concrete, etc.
 - .3 Saturate surface with water,

- .4 Cover hardened concrete with a mortar of same composition than mortar used for concrete and add a bonding agent following the manufacturer's recommendations.
- .7 When preparing construction joints for deep members, pour concrete in excess and screed one (1) or two (2) hours after discharge.
- .8 Where indicated, respect concreting sequence. Allow a minimum of seven (7) days before pouring concrete in neighboring section.

3.8 CONCRETING OVER EXISTING CONCRETE WORKS

- .1 Pour concrete shown on drawings to CSA A23.1, article 7.4.
- .2 Clean thoroughly concrete used as substrate to obtain a surface free of foreign matter, dusts, damaged concrete, etc.
- .3 When needed, clean existing reinforcing bar by grinding or any other means except sandblasting or waterblasting. When loss of steel exceeds 25% of reinforcing bar section, replace existing reinforcing bars and add dowels if needed.
- .4 Obtain the Representative of the Ministry approval for exposed surfaces before placing formworks.
- .5 Prepare surface to CSA A23.1 article 7.8.3.2, method c) or d). All laitance, dirt, dust, debris, grease or any other foreign matter that may adversely affect bond between existing and new concrete. Surface shall be rough and clean before placing new concrete.
- .6 Apply bonding agent just before placing new concrete, to CSA A23.1 article 7.8.4.2 and manufacturer's recommendations.
- .7 Existing concrete surfaces shall be saturated surface dry (SSD) before placing new concrete. Moisten existing concrete surface for a minimum of four (4) hours before concreting and allow one (1) hour as to drain water from surface before placing new concrete.

3.9 CONCRETE CURING AND FINISHING

- .1 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radius edges unless otherwise indicated.
 - .2 Using chisel, break concrete projections left by the open joints of the formwork.
 - .3 Finishing to section 03 35 00 – Concrete Finishing.
 - .4 Curing to section 03 39 00 – Concrete Curing.
 - .5 Do not place load upon new concrete before concrete has reached the required strength.
-

3.10 CONSTRUCTION TOLERANCES

- .1 Follow requirements of CSA A23.1, article 6.4, for construction tolerances for cast-in-place concrete.
- .2 In case of non-compliance, the Representative of the Ministry may require that the non-compliant element be demolished and constructed anew, following tolerances to article 6.4, without any additional cost. Alternatively, a permanent deduction may be applied to the global price of the contract as a compensation for the lower quality of the work. The Representative of the Ministry will be the sole judge of the appropriate withholding amount, which may amount up to the equivalent to the cost of demolition and reconstruction of the element.

3.11 FIELD QUALITY CONTROL

- .1 Site tests: conduct tests as follows and in accordance with section 01 45 00 - Quality Control. Submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory, certified to CSA A283, designated by the Representative of the Ministry for review to CSA A23.1.
- .3 The Contractor shall cooperate fully to facilitate testing by allowing access to work site and equipment, providing manpower and materials needed to prepare cylinders, and providing a proper secure space for storing samples.
 - .1 Inform testing laboratory at least twenty-four (24) hours before pouring concrete, no matter the volume of concrete to be poured.
 - .2 Set aside on site a place protected against weather conditions where concrete cylinders will be stored, at a temperature of at least 10°C and at most 25°C before being delivered to laboratory.
- .4 One group of test shall be carried out to evaluate compressive strength for every 50 m³ of concrete, but not less than one group of test for each class of concrete poured in a given day.
- .5 Tests shall be carried out in accordance with the indication of article 2.4 of this specification. A group of test shall include, as a minimum, three (3) cylinders, one slump test and one air content test. Test air content for each concrete truck when concrete will be exposed to freeze-and-thaw cycles or exposed to de-icing salts.
- .6 Slump tests shall be carried out in sufficient number as to ensure uniform consistency of concrete.
- .7 Testing laboratory shall take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .8 The Ministry will pay for the costs of tests indicated above.

- .9 Non-Destructive Methods for Testing Concrete: to CSA A23.2.

3.12 INTERPRETATION OF COMPRESSIVE STRENGTH TEST RESULTS

- .1 Interpretation of compressive strength test results will be done in accordance with article 4.4.6.6.1 of CSA A23.1 standard. Concrete meets the requirements of this specification for compressive strength if:
- .1 The average value of a group of three (3) consecutive tests equals or exceeds the specified strength.
 - .2 Compressive strength equals at least the specified resistance minus 3.5 MPa for all individual tests.
- .2 When test results do not meet the above requirements, the Representative of the Ministry may require, without any additional costs from the Contractor, that:
- .1 Mix proportions are changed for the remainder of work,
 - .2 Additional curing is done on the portion of the work represented by test specimens,
 - .3 Cores be drilled from the portion of structure in question, in accordance with ASTM C 42/C 42M, ASTM C 39/C 39M and CSA A23.2-14C, interpreted to article 4.4.6.6.2 of CSA A23.1,
 - .4 The portion of structure is submitted to load tests, to CSA A23.3, article 20.

3.13 NON-COMPLIANT WORK

- .1 Structural deficiency.
- .1 Work or part of work has a structural deficiency when concrete strength, as interpreted by article 3.12 of this specification, does not meet the specified resistance.
 - .2 Moreover, work or part of work presents a structural deficiency if one of the following conditions occur:
 - .1 Concrete mix formula was not approved prior to pouring,
 - .2 Representative of the Ministry and/or testing laboratory was not informed before concreting,
 - .3 Concrete pouring was not done following the requirements of this specification.
 - .3 Notwithstanding the results of any tests done during concrete pouring, work or part of work presenting a structural deficiency has interpreted by article 3.13.2 is considered as if not meeting the specified strength requirement per article 3.12.1.
 - .4 When specific requirements are given for mixes formula, such as chloride ion permeability or spalling due to salt, to ensure or improve durability of concrete, failure to meet these requirements is considered a structural deficiency.

- .2 Esthetic deficiency.
 - .1 Work or part of work has an esthetic deficiency when concrete is soiled, contaminated by debris, contains honeycombs, surface voids or bug holes, protrusion, smudges, change in colors or any other similar defect. Work that does not respect the finish criteria defined in the article 3.4 section 03 11 00 – Concrete Forming of the specifications is also considered as having an esthetic deficiency.
 - .2 Notwithstanding the article above, presence of surface voids, bug holes and/or honeycombs in concrete with an exposition class of C-1 or C-XL is considered presenting a structural deficiency as in article 3.13.4.
 - .3 The following definitions shall be used when determining esthetic deficiencies:
 - .1 Surface voids or bug holes: Small regular or irregular cavities, usually not exceeding 15 mm in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.
 - .2 Honeycombs: Concrete or part of concrete that, due to lack of the proper amount of fines or vibration, contains abundant interconnected large voids or cavities; honeycombs may result from improper consolidation. Any regular or irregular voids exceeding 15 mm in diameter are considered honeycombs.
 - .3 Protrusion: any part of concrete work protruding 10 mm or more from concrete work.
 - .4 Smudges: any spillage of concrete from formwork.
 - .5 Changes in color: any change in color that affects adversely the overall look of the concrete work.
- .3 Cracking in new concrete work:
 - .1 Presence of cracks with openings of 0.3 mm or more in new concrete work is considered a deficiency. Presence of a network of cracks with openings of 0.2 mm or more is considered a deficiency. One or more cracks of a total length exceeding 1.5 m on an area of 0.25 m² constitute a network of cracks.

3.14 CORRECTION OF DEFICIENCIES

- .1 Structural deficiency.
 - .1 If, after taking the measures identified in section 3.12.2 of this specification, the Representative of the Ministry still believes that concrete of part of or of all of the works does not meet the strength requirements, he may require strengthening or replacement (demolition and reconstruction) of part of or of the whole work as appropriate. All costs shall be assumed by the Contractor.
 - .2 When a structural deficiency is identified resulting in a lesser durability of the work, but without affecting strength, the Representative of the Ministry may require that:

- .1 One or more compensatory measures to obtain a work of a durability equivalent, in the opinion of the Representative of the Ministry, to that which would have been obtained with the use of a concrete meeting the requirements of this specification, the costs will be assumed by the Contractor;
 - .2 A permanent deduction may be applied to the global price of the contract as a compensation for the lower quality of the work. The Representative of the Ministry will be the sole judge of the appropriate withholding amount determined on the basis of future expenses (maintenance and repairs) due to the lesser durability, which may amount up to the equivalent of the cost of demolition and reconstruction of the element.
- .2 Esthetic deficiency.
 - .1 Make sure the Representative of the Ministry has inspected defects before beginning surface repairs.
 - .2 Any damaged concrete, soiled or containing debris shall be repaired in accordance with the Representative of the Ministry directives.
 - .3 Honeycombs made visible after removal of formworks will be scraped to solid concrete, to a minimum depth of 10 mm. Repairs shall be circumscribed by saw cuts of a regular shape without angles of 60 degrees or less. Zone of repairs shall extend at least 50 mm into sound concrete near honeycombs.
 - .4 When necessary, concrete faces will be cut to obtain sharp regular edges using saw. Surfaces will be cleaned and cavities coated with an epoxy bonding agent then filled with an epoxy modified grout, held in place by formworks if necessary.
 - .5 Protrusions, burrs, smudges, etc. due to formworks shall be grinded.
 - .6 If concrete faces finish is not satisfactory, if the extent of repair needed is too extensive or if concrete presents significant changes of colors, the Representative of the Ministry may require the application of a coating product (cement-based paint, epoxy-based grout, or any other product deemed appropriate) on all exposed faces, without any added costs.
 - .7 The repairs must be executed in accordance with the requirements of the article 3.4 of the section 03 11 00 – Concrete Forming of the specifications.
- .3 Cracks in new concrete.
 - .1 Cracks with openings of 0.3 mm or more will be injected as described in section 03 15 00 – Concrete Accessories.
 - .2 Where a network of cracks is present, the Representative of the Ministry may require one of the following measure:
 - .1 Application of a coating product (cement-based paint, epoxy-based grout, or any other product deemed appropriate),
 - .2 Partial demolition and reconstruction with an appropriate product.

- .4 Procedure for repairing deficiencies.
 - .1 The Contractor is responsible to submit methods for repairing deficiencies. He needs to obtain the Representative of the Ministry approval of said method before proceeding with reparations.
 - .2 Refer to Guideline No. 310.1R *Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion* by ICRI when preparing methods for repairing deficiencies. Refer to chapters 5 to 7 when determining geometry and extent of surfaces to demolish prior to repairing.
 - .3 Refer to Guideline No. 320.2R *Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces* by ICRI when selecting repair materials.
 - .4 Refer to Guideline No. 320.1R *Guide for Selecting Application Methods for the Repair of Concrete Surfaces* by ICRI when selecting application method for repair materials.
- .5 Inform the Representative of the Ministry after finishing demolition prior to reparation, at least forty-eight (48) hours before applying repair materials, to allow for inspection.
- .6 All costs associated with additional work site supervision due to deficiency repairs are considered the responsibility of the Contractor and will be paid by applying a permanent deduction to the contract.

FIN DE SECTION

1. General

1.1 RELATED REQUIREMENTS

- .1 Section 03 11 00 – Concrete Forming.
- .2 Section 03 15 00 – Concrete Accessories.
- .3 Section 03 20 00 – Concrete Reinforcing.
- .4 Section 03 30 00 – Cast-in-Place Concrete.
- .5 Section 03 39 00 – Concrete Curing.

1.2 PRICING AND PAYMENT PROCEDURE

- .1 No measurement will be made under this Section.
 - .1 Include concrete finishing pricing in concreting work package in section 03 30 00 – Cast-in-Place Concrete.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C 920-14a, Standard Specification for Elastomeric Joint Sealants.
 - .2 ASTM E 430-11, Standard Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry.
 - .3 ASTM E 965-96(2006), Standard Test Method for Measuring Pavement Macrottexture Depth Using a Volumetric Technique.
 - .4 ASTM E 1155M-14, Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers [Metric].
 - .5 ASTM F 710-11, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - .6 ASTM F 1869-11, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - .2 Canadian Standard Association (CSA)/CSA International.
 - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .3 Concrete Floors Contractors Association of Canada (CFCA).
 - .1 Specification Bulletin, Polished Concrete – Gloss & Aggregate Exposure, April 12, 2011.
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- .4 International Concrete Repair Institute (ICRI).
 - .1 Guideline No 310.2R-2013 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.4 PERFORMANCES

- .1 Products and workmanship quality: in accordance with section 01 61 00 – Common Product Requirements.
- .2 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

1.5 TECHNICAL DATASHEETS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets. WHMIS datasheets for products used on concrete shall include volatile organic compound (VOC) content. Datasheets shall be in accordance with Health Canada and Human Resources and Skills Development Canada requirements.
- .3 Submit instructions relating to products application.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse/recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic in designated containers.
- .3 Ensure that empty recipients are sealed and stored properly before elimination.
- .4 Divert unused hazardous material from landfill to an official hazardous material collections site as approved by the Representative of the Ministry, in accordance with all applicable legislation.
- .5 Dispose of waste generated by work (scarification, stripping of floor, etc.) in an environmentally sound manner.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Temporary lighting:
 - .1 Minimum 1200 W light source, placed 2.5 m above floor surface, for each 40 square meters of floor being treated.
- .2 Electrical power:

- .1 Provide sufficient electrical power to operate equipment normally used during construction.
- .3 Work area:
 - .1 Make work area water tight protected against rain and detrimental weather conditions.
- .4 Temperature:
 - .1 Maintain ambient temperature of not less than 10 degrees C from 7 days before installation to at least 48 hours after completion of work and maintain relative humidity not higher than 40% during same period.
- .5 Moisture:
 - .1 Ensure concrete substrate is within moisture limits prescribed by flooring manufacturer. Moisture content shall be controlled by laboratory test and a written report presented prior to product application.

1.8 ACCEPTABLE MATERIALS

- .1 Where materials are specified by trade name refer to the Instructions to Tenderers for a procedure to be followed in applying for approval of alternatives

2. Products

2.1 CHEMICAL HARDENERS

- .1 Liquid hardener (densifier) type 1.
 - .1 Use a sodium silicate product, translucent, acting as densifier and dustproofersuch as :
 - .1 MasterKure HD 100WB (formerly Sonosil) by BASF;
 - .2 Sikafloor 3S by SIKA;
 - .3 Eucosil by Euclid;
 - .4 Mapecrete Hard SI by MAPEI;
 - .5 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.

3. Execution

3.1 FINISHING OF FORMED SURFACES

- .1 Clean and finish formed surfaces in accordance with article 7.9.2 of CSA A23.1 standard. Use smooth-form finish to article 7.9.2.6 for exposed surfaces. Rough-form finish to article 7.9.2.5 will be deemed acceptable for all other surfaces.
- .2 For all corners of exposed concrete, chamfer corners to 25 mm, even if no indications are given on drawings.
- .3 Refer to section 03 11 00 – Concrete Forming for patching of form tie holes.

3.2 PREPARATION OF SLABS

- .1 Examine slab surfaces and environmental and workmanship conditions to ensure that all manufacturer's requirements are met for the application of finishing products. Verify slab levels in regards to shop drawings and manufacturer's requirements.

3.3 SLAB FLATNESS TOLERANCES

- .1 Tolerances for slab and floor finish shall be in accordance to table 22 of CSA A23.1 standard. Method to ASTM E 1155M shall be used to determine slab flatness by determining F numbers.
- .2 Refer to article 7.6.1.1 and 7.6.1.4 of CSA A23.1 and the following table to determine slab flatness and methods of finishing. When a slab does not belong specifically to a category listed on the following table or no other specifics indications are given elsewhere, use tolerances associated with class B.

Class	Examples	Recommended Method	Global F number	
			F _F	F _L
A	"Conventional" slab	Manual screeding, trowelling using steel trowels	20	15
B	"Flat" slab	Manual screeding, bull floating and trowelling using steel trowels.	25	20
C	"Very Flat" slab on ground	Manual or mechanical screeding, bull floating and trowelling using steel trowels.	35	25
D	"Extremely Flat" slab on ground	Concreting in narrow strips, mechanical screeding, bull floating and trowelling using steel trowels	45	35

*Refer to table 21 of CSA A23.1 standard. The above table was developed using the information contained in table 21.

- .3 Refer to following table to determine which class applies to different concrete surfaces.

Class	Surfaces
A	Floors to support terracotta or ceramic tiles or terrazzo Roof to support insulating panel, composite roof or waterproofing membrane
B	Ramps for pedestrian or vehicle Floors permanently covered (glued tiles, linoleum, carpets, etc.) Any exposed concrete surface not belonging to a superior category.
C	Warehouse
D	Loading dock

3.4 SLAB FINISH

- .1 Concrete slab finish shall be done in accordance with CSA A23.1 article 7.6 and ACI 308R requirements. Requirements hereby presented shall be read in conjunction with those standards.
- .2 Do not sprinkle dry cement or dry cement and sand mix on concrete surfaces.
- .3 Control excess bleeding water using methods to CSA A23.1. Avoid any damage to concrete surfaces.
- .4 Initial Finishing.
- .1 After the placing, spreading and vibrating of concrete, screed surfaces using properly designed screed or straight-edge.
- .2 Using bull float, darby or mechanical equipment as appropriate, work concrete to remove high spots and ridges and to fill voids and hollows. Coarse aggregate shall be slightly embedded into concrete. Surface level shall be as indicated on drawings.
- .3 Complete initial finishing before any bleeding or free water appears on the surface of concrete.
- .5 Final Finishing – General.
- .1 Final finishing includes edging, grooving, floating and trowelling. Commence final finishing as soon as bleed water has disappeared and concrete has hardened enough to prevent working of excess mortar to the surface.

- .2 Unless otherwise indicated, surfaces shall be monolithic, trowelled using steel trowel to obtain a smooth, non-slip, without streaks, trowel marks or ripples.
- .3 Finishing quality shall meet all quality requirements for the installation of flooring.
- .6 Final Finishing – Stairs and landings.
 - .1 Finishing quality shall be sufficient to allow proper installation of nonslip coating. Surfaces shall be monolithic, trowelled using steel trowel to obtain a smooth, abrasive, without streaks, trowel marks or ripples.
 - .2 When specified on architectural drawings, embed one carborundum band in per step over the full width of the stair.
 - .3 Special care shall be taken to obtain uniform horizontal step nosing.
- .7 Final Finishing – Ramps.
 - .1 If needed, surface finish shall allow installation of waterproof membrane. Surface shall be smooth, without streaks, trowel marks or ripples. Finish shall be monolithic, trowelled using wood trowels, and nonslip grooves shall be added to a ramp without membrane.
- .8 Finish slab with fibres as to ensure that no fibres remain visible on the surface of the slab. The Contractor shall take any precaution required during finishing to obtain as flat a surface as possible.
- .9 Ensure that tolerances indicated in section 3.3 are met.
- .10 Other works.
 - .1 Using carborundum, grind straight edges of concrete to obtain a 3 mm radius.

3.5 CONTROL JOINTS

- .1 Before twenty-four (24) hours have passed following concreting, cut control joints in accordance with CSA A23.1 standard,
- .2 For slabs and toppings, use specialized cutting tools to cut control joints – hand operated concrete saw shall not be used. Vertical joints shall be cut immediately after formwork removal.
- .3 When concrete has hardened and surface is dry, follow requirements of section 03 15 00 – Concrete Accessories for joints caulking.
- .4 Unless otherwise indicated, refer to drawings for control joints location. Where there is no indications, use the general requirements as follow :
 - .1 Saw cut width shall be 6 mm.
 - .2 Saw cut depth shall be 40 mm. Where reinforcing steel is present, depth shall be modified as to prevent any damage to reinforcing steel.

- .3 Maximum spacing between joints on slabs and concrete toppings shall be 4.5 m in each direction, as indicated in article 7.2.2 of CSA A23.1 standard.

3.6 APPLICATION OF LIQUID HARDENER

- .1 Follow manufacturer's recommendations when applying hardener on surface indicated on drawings.
- .2 Surface preparation:
 - .1 Concrete curing must be completed prior to beginning works related to the application of liquid hardener.
 - .2 Clean concrete surface from all debris or material that may be detrimental to the penetration of the hardener, including but not limited to curing compound, sealant, dust, floor cover, paints, oil, wax, etc.
 - .3 Allow a minimum of 24 hours to air-dry the concrete surface prior to applying liquid hardener.
- .3 In hot weather, predampen concrete and begin application of hardener when no standing water remains.
- .4 Apply hardener using low pressure sprayer onto the surface.
- .5 Use brooms or brushes on an auto-scrubber to distribute the hardener and help it penetrate into concrete.
- .6 Surface shall remain wet at least 30 minutes – spray more hardener as needed.
- .7 When hardener begins to thicken and gel underfoot (typical reaction time is 30 to 60 minutes), vaporize lightly with water and move the excess material onto the next area to be treated.
- .8 When finished, clean all excess hardener. Ensure that no residue remains on concrete following clean-up.
- .9 As needed, on porous surface or for concrete surface with textured finish, repeat application of hardener after allowing a minimum of 2 to 4 hours.
- .10 Joints to be filled after application of hardener will require thorough cleaning before installation of filler.

3.7 SLAB LEVELLING

- .1 Where slab flatness does not meet requirements, apply a cementitious floor screed in accordance with section 03 15 00 – Concrete Accessories to obtain a levelled surface.
- .2 Prepare surfaces by sandblasting, by manual scarification or manual chipping using a "Needle Gun" to provide a surface profile CSP-4 as specified in guideline 310.2R

Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair of ICRI.

- .3 Apply cementitious floor screed per manufacturer's recommendations.

END OF SECTION

1. General

1.1 RELATED REUIREMENTS

- .1 Section 03 11 00 – Concrete Forming.
- .2 Section 03 15 00 – Concrete Accessories.
- .3 Section 03 20 00 – Concrete Reinforcing.
- .4 Section 03 30 00 – Cast-in-Place Concrete.
- .5 Section 03 35 00 – Concrete Finishing.

1.2 PRICING AND PAYMENT PROCEDURE

- .1 No measurement will be made under this Section. Curing shall be considered integral part of concreting works.
 - .1 Include concrete curing pricing in concreting work package in section 03 30 00 – Cast-in-Place Concrete.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C 171-07, Standard Specification for Sheet Materials for Curing Concrete.
 - .2 ASTM C 309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .3 ASTM C 1315-11, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- .2 Canadian Standard Association (CSA)/CSA International.
 - 1. CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.4 ACTIONS AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets.
- .3 At least fourteen (14) days prior to curing concrete, submit to the Representative of the Ministry methods for curing concrete and to control quality of concrete curing.

1.5 QUALITY CONTROL

- .1 Quality control : in accordance with section 01 45 00 – Quality Control.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse/recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 ACCEPTABLE MATERIALS

- .1 Where materials are specified by trade name refer to the Instructions to Tenderers for a procedure to be followed in applying for approval of alternatives

2. Products

2.1 MATERIALS

- .1 Water: to CSA A23.1, article 4.2.2.
- .2 Membranes, sheet materials: to ASTM C 171 such as :
 - .1 UltraCure by McTech Group;
 - .2 Transguard 4000 by Reef industries;
 - .3 ConKure by Sweeney Materials;
 - .4 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .3 Curing compound: white or colorless, to CSA A23.1, ASTM C 309 or CAN/CGSB 19.24. Compound to ASTM C 1315 may be used conditional to approval.
- .4 Jute or burlap cloth: to ASTM C 171 and AASHTO M 182.

3. Execution

3.1. GENERAL REQUIREMENTS

- .1 Follow requirements of section 03 30 00 – Cast-in Place Concrete for concreting.
 - .2 Concrete curing to CSA A23.1, article 7.7 and ACI 308R. Refer to those standards when choosing curing methods.
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- .3 Slabs and walls more than 500 mm thick are considered mass concrete.
- .4 Use of curing compound is prohibited unless written authorization is given. If the Contractor wishes to use curing compounds, he shall submit in writing curing methods and all relating documents including technical datasheets for compounds. The Representative of the Ministry may or may not approve use of curing compounds.
- .5 Whenever possible, curing methods shall be chosen such that concrete is moistened by direct contact with water.
 - .1 Use methods reviewed to Representative of the Ministry satisfaction and as defined in CSA A23.1 standard to eliminate bleeding water. Ensure no damage is done to concrete surfaces.
- .6 During curing, ensure that concrete remains unloaded and is protected against chocks, vibrations, weather conditions or any other element that might affect quality of works.

3.2. WET CURING

- .1 Water used for curing concrete shall be clean and without matters that may leave marks on concrete.
- .2 Exposed faces of concrete shall be moistened for at least seven (7) days and protected against weather conditions and other works. Concrete temperature shall remain at or above ten (10) degrees Celsius.
- .3 When concrete has to be protected against cold weather, maintain protection at least twelve (12) hours after the end of wet curing.
- .4 When temperature is twenty-five (25) degrees Celsius or more, or twenty (20) degrees Celsius for mass concrete, use water jet, wet sand or jute for initial curing of concrete.
 - .1 Moisten formworks before concreting and until formworks are removed.
- .5 Use two layers of constantly wet jute or burlap clothes for curing walls or other vertical elements.
- .6 Non-formed concrete surfaces shall remain wet for a minimum of seven (7) days.
- .7 Formed concrete surface (beams, columns, walls, etc.) shall be cured for at least seven (7) days, as follows:
 - .1 Before formwork removal: three (3) days, but not less than the duration in section 03 11 00 – Concrete Forming.
 - .2 Wet curing following formwork removal: four (4) days.

3.3. MEMBRANE CURING

- .1 Effect of sun, wind, cold or rain can adversely affect concrete curing. Exposed faces of concrete shall be covered partially or completely by tarpaulin or protected by any other means approved by the Representative of the Ministry.
- .2 Rather than using a method in accordance with article 3.2 of this section, the Contractor may use blankets specially designed for curing concrete. Depending on weather conditions, use sheet materials designed for hot weather. Method for using sheet materials shall be as follow:
 - .1 Begin placing immediately after concrete has hardened enough to prevent damages.
 - .2 Spray water over a first strip where sheet materials will be installed. Surface shall be covered by 3 to 6 mm of water.
 - .3 Unroll sheet materials over wet concrete. Add water when needed.
 - .4 Use squeegee to smooth out wrinkles and air bubbles.
 - .5 Spray water over next strip and repeat preceding operations. Lap strips over 75 mm minimum. At roll ends, overlap over 300 mm minimum. Cover the entire surface of slab.
 - .6 Inspect slab frequently and repair immediately any damage to sheet materials.
 - .7 Remove sheet materials after seven (7) days of curing or later. Do not reuse sheet materials.

3.4. USE OF CURING COMPOUNDS

- .1 Where authorized, curing compounds shall be used if compatible with floor finish.
 - .1 Curing compound shall be used following manufacturer's recommendations. Compound shall be selected so that dust will not deposit on concrete surface and so that evaporation of water contained in concrete does not occur. Curing compound should not affect architectural flooring.
 - .2 Use curing compounds compatible with finishing products. Submit a written document certifying that all products applied on concrete surfaces are compatible. The Contractor is the sole responsible to determine and demonstrate compatibility between all products applied on concrete surfaces.

END OF SECTION