

**Part 1      General**

**1.1          SECTION INCLUDES**

- .1      Materials, design, and execution of concrete reinforcing.

**1.2          RELATED SECTIONS**

- .1      Section 03 30 00 - Cast-In-Place Concrete

**1.3          REFERENCES**

- .1      2012 Ontario Building Code
- .2      2015 National Building Code
- .3      American Concrete Institute (ACI)
  - .1      SP-66(04) - ACI Detailing Manual 2004
- .4      Reinforcing Steel Institute of Ontario / Canada (RSIO / RSIC):
  - .1      Reinforcing Steel Manual of Standard Practice (2004);
- .5      American Society for Testing and Materials (ASTM):
  - .1      ASTM A82 / A82M-05a, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement;
  - .2      ASTM A184 / A184M-06, Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement;
  - .3      ASTM A185 / A185M-06e1, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete;
  - .4      ASTM A496 / A496M-05, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement;
  - .5      Rod Mats for Concrete Reinforcement;
  - .6      ASTM A775 / A775M - 06, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
- .6      Canadian Standards Association (CSA)
  - .1      CAN/CSA-A23.1-04, Concrete Materials and Methods of Concrete Construction.
  - .2      CAN3-A23.3-04, Design of Concrete Structures.
  - .3      CAN/CSA-G30.18-M92 (R2002), Billet-Steel Bars for Concrete Reinforcement.
  - .4      CAN/CSA-G40.21-04, Structural Quality Steel.
  - .5      CAN/CSA-G164-M92 (2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .6      CSA W186-M1990 (R2002), Welding of Reinforcing Bars in Reinforced Concrete Construction.

#### **1.4 SHOP DRAWINGS**

- .1 Submit shop drawings and bar lists in accordance with Section 01 33 00 - Submittal Procedures. Allow ten working days for shop drawing review before commencing fabrication.
- .2 Indicate on shop drawings, bar bending details, lists, quantities of reinforcement and wire mesh, sizes, spacing, locations of reinforcement and mechanical splices if approved by Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings. Indicate sizes, spacing and locations of chairs, spacers and hangers. Prepare reinforcement drawings in accordance with Reinforcing Steel Manual of Standard Practice - by Reinforcing Steel Institute of Canada. ANSI/ACI 315 and ACI 315R, Manual of Engineering and Placing Drawings for Reinforced Concrete Structure.
- .3 Indicate (and detail) all proposed construction joints.
- .4 Show reinforced concrete and reinforced masonry walls and beams in full elevation and detail all bars.
- .5 When requested, for slab construction, show top and bottom layer slab reinforcing on separate plans. Detail sections to fully illustrate bar placement at dowels, curbs, openings, changes of elevation, beams, stairs, and areas of congested steel, and wherever else required.
- .6 Detail placement of reinforcing where special conditions occur.
- .7 Design and detail lap lengths and bar development lengths to CAN/CSA-A23.1 and CAN3-A23.3, unless otherwise specified on drawings. Use Class "B" tension splices unless otherwise noted.
- .8 Indicate details for placement of dowels.
- .9 CAD drawings of the Departmental Representative may be used as a background for the preparation of shop drawings provided that a license agreement, provided by the Departmental Representative, is signed by the reinforcing trade.

#### **1.5 SUBSTITUTIONS**

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

#### **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise.
- .2 Reinforcing steel: weldable low alloy steel deformed bars to

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CAN/CSA-G30.18.

- .3 Cold-drawn annealed steel wire ties: to ASTM A82/A82M;
- .4 Deformed steel wire for concrete reinforcement: to ASTM A496/A496M;
- .5 Welded steel wire fabric: to ASTM A185/A185M. Provide in flat sheets only.
- .6 Welded deformed steel wire fabric: to ASTM A497 / A497M. Provide in flat sheets only.
- .7 Epoxy coating of non-prestressed reinforcement: to ASTM A775 / A775M.
- .8 Galvanizing of non-prestressed reinforcement: to CSA G164, minimum zinc coating 600g/m<sup>2</sup>.
- .9 Chairs, bolsters, bar supports, spacers adequate for strength and support of reinforcing under construction conditions: to CAN/CSA-A23.1. Use chairs with plastic coated feet where slab and beam soffits will be exposed.
- .10 Mechanical splices: subject to approval of Departmental Representative.
- .11 Plain round bars: to CAN/CSA-G40.21.

## **2.2 FABRICATIONS**

- .1 Fabricate reinforcing steel in accordance with CAN/CSA-A23.1, ACI SP-66 - Detailing Manual, and RSIO/RSIC Reinforcing Steel Manual of Standard Practice unless indicated otherwise.
- .2 Fabricate to tolerances specified by RSIO/RSIC Reinforcing Steel Manual of Standard Practice unless indicated otherwise.
- .3 Obtain Departmental Representative's approval for locations of reinforcement splices other than those shown on placing drawings.
- .4 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.
- .5 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists. Bundling and transportation of epoxy coated bars shall be in accordance with ASTM A775/A775M.
- .6 Discard and re-fabricate bars having extra bends, cracks, splits, kinks or excessive rust.

## **2.3 SOURCE QUALITY CONTROL**

- .1 Upon request, provide Departmental Representative with certified copy of mill test report of reinforcing steel to be supplied, showing physical and chemical analysis, corresponding to identification tagging of material at the fabrication plant prior to commencing reinforcing work.
- .2 Inform Departmental Representative of proposed source of material

to be supplied. Unidentified reinforcement shall not be allowed.

**Part 3 Execution**

**3.1 PLACING REINFORCEMENT**

- .1 Place reinforcing steel to CAN/CSA-A23.1 and as indicated on reviewed shop drawings.
- .2 Set tie wires so that ends are directed into concrete, not toward exposed concrete surfaces. Un-coated metal tie wires shall not project more than 5mm into the concrete cover.
- .3 Do not tack weld reinforcing unless shown on the Structural Drawings, or approved by the Departmental Representative.
- .4 Do not displace reinforcing to accommodate sleeves, inserts, waterstops, reglets, or other cast-in hardware.
- .5 Arrange for reinforcing steel personnel to be present at all times concrete is poured to ensure that reinforcing remains in place as tied, and to take remedial action as required.
- .6 Maximum chair spacing unless otherwise required by the Drawings or by "Reinforcing Steel Manual of Standard Practice":

| Bar Size | Chair Spacing |
|----------|---------------|
| 10M      | 600mm         |
| 15M      | 1200mm        |
| 20M      | 1600mm        |
| 25M      | 2000mm        |

Provide additional chairs and support bars as deemed necessary by the Departmental Representative.

- .7 Place welded wire fabric in as long lengths as practical lapping at least one mesh, (200mm minimum) and tie, unless noted on the Drawings.
- .8 Ensure welded wire fabric is adequately supported at centre of slab, or where indicated in the drawings, during concrete placing.
- .9 Obtain Departmental Representative's approval of reinforcing steel and position before placing concrete. Give 24-hour notice prior to the time at which approval is required. For walls and deep beams, ensure that one side of formwork is left open for inspection of reinforcing steel.
- .10 Ensure that all steel is in place, and tied, at the time at which the Departmental Representative's approval has been requested, and prior to the start of concrete placing.
- .11 Clean reinforcing and forms before placing concrete, and adjust reinforcing and forms immediately before concrete is poured, as required, to ensure bars and inserts are placed correctly.
- .12 Obtain approval from Departmental Representative for all construction joint locations. Ensure additional reinforcement at construction joints is available before commencing pour.

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- .13 Do not force reinforcing steel inserts or anchor bolts into fresh or semi-hardened concrete.
- .14 Ensure cover to reinforcement is maintained during concrete pour.
- .15 Placing of the epoxy-coated reinforcing bars, where epoxy coated bars are required on the drawings, shall include:
  - .1 Support epoxy-coated reinforcing bars from formwork on plastic coated wire bar supports, or on bar supports made of dielectric material for a minimum distance of 50mm from the point of contact with the epoxy-coated bar.
  - .2 Reinforcing bars used as support bars shall also be epoxy-coated.
  - .3 In walls having epoxy-coated reinforcing bars, spreader bars shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.
  - .4 Fasten epoxy-coated reinforcing bars with nylon-, epoxy-, or plastic-coated tie wire, or other acceptable material.
  - .5 Splice reinforcing bars only as required or permitted by the Contract Documents, or as authorized by the Departmental Representative.
  - .6 Do not cut reinforcing bars in the field unless permitted by Departmental Representative. When epoxy-coated reinforcing bars are cut in the field, coat ends of bars with same material used for repair of coating damage.
  - .7 Protect epoxy and paint coated portions of bars with covering during transportation and handling.

### **3.2 FIELD BENDING**

- .1 Do not field bend reinforcing bars partially embedded in concrete, except as indicated in the Contract Documents or permitted by the Departmental Representative.
- .2 Do not field bend or field weld reinforcement except where indicated or authorized by Departmental Representative.
- .3 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .4 Replace bars which develop cracks or splits during field bends.
- .5 Bending of epoxy-coated reinforcing bars:
  - .1 Provide adequate ventilation when heat is used to field bend epoxy-coated reinforcing bars.
  - .2 When epoxy-coated reinforcing bars are field bent, repair coating damage in accordance with ASTM A775/A775M.

**END OF SECTION**

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**1.1           RELATED SECTIONS**

- .1        Section 03 20 00 - Concrete Reinforcing
- .2        Section 05 12 23 - Structural Steel For Buildings

**1.2           REFERENCES**

- .1        Conform to Ontario Building Code 2012.
- .2        American Society for Testing and Materials (ASTM)
  - .1        ASTM C260-06, Standard Specification for Air-Entraining Admixtures for Concrete.
  - .2        ASTM C309-06, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete;
  - .3        ASTM C494/C494M-05a, Standard Specification for Chemical Admixtures for Concrete.
  - .4        ASTM C679-03, Standard Test Method for Tack-Free Time of Elastomeric Sealants;
  - .5        ASTM C979-05, Standard Specification for Pigments for Integrally Colored Concrete.
  - .6        ASTM C1017/C1017M-03, Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.
  - .7        ASTM D412-06a, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension;
  - .8        ASTM D638-03, Standard Test Method for Tensile Properties of Plastics;
  - .9        ASTM D2240-05, Standard Test Method for Rubber Property - Durometer Hardness;
- .3        Canadian Standards Association (CSA)
  - .1        CAN/CSA-A3000-03, Cementitious Materials Compendium.
  - .2        CAN/CSA-A23.1-04, Concrete Materials and Methods of Concrete Construction.
  - .3        CAN/CSA-A23.2-04, Methods of Test and Standard Practices for Concrete.
  - .4        CAN/CSA S413-94 (2007) - Parking Structures

**1.3           SAMPLES**

- .1        Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Where requested, submit samples of proposed colour of cement and type of proposed aggregate, for all exposed-aggregate and other architecturally-exposed concrete, for approval by Departmental Representative. Minimum sample panel size 600x600x75.

#### **1.4 CERTIFICATES**

- .1 Provide certification that mix proportions selected will produce concrete of specified quality and yield and that strength will comply with CAN/CSA-A23.1, Clause 4.4.6.
- .2 Provide certification that plant, equipment, and all materials to be used in concrete comply with the requirements of CAN/CSA-A23.1.

#### **1.5 QUALITY ASSURANCE**

- .1 Inspection and testing of concrete and concrete materials shall be carried out by a testing laboratory designated by the Departmental Representative, in accordance with CAN/CSA-A23.1 and A23.2.
- .2 Costs of tests will be paid under a cash allowance. See Section 01 22 00
- .3 Ship prepaid, 3 control cylinders of each strength of concrete from each pour, and not less than 3 from each 60m<sup>3</sup> of concrete or part thereof. Make, handle, store and cure in accordance with CAN/CSA-A23.1. Make strength test of one cylinder from each sampling at 7 days, and of the other two cylinders at 28 days.
- .4 Prepare one additional test cylinder when concrete is being placed at temperatures of 10°C or less, and cure at site under same conditions as concrete it represents. Additional test cylinders shall be prepared at the discretion of the Departmental Representative or Testing Agency.
- .5 Provide equipment and make slump tests with air entrainment tests in accordance with CAN/CSA-A23.2.
- .6 Field-cured (pull-out) cylinders shall be prepared to verify in-situ concrete strengths for stripping of formwork, particularly in cold weather. Pull-out cylinders shall be cast and stored on site until time of testing, in accordance with the recommendations of the Testing Agency. Alternate means of establishing in-situ strength shall be to the approval of the Testing Agency and the Departmental Representative.
- .7 Report test results in writing to the Departmental Representative and Contractor on the same day tests are made. Include in reports location of pours in construction, date and time of pour, time in mixer prior to discharge, temperature of concrete, weather, slump, air content, density, and class of concrete. Report non-conformance with the Contract Documents in detail.
- .8 Maintain accurate records of poured concrete items to indicate date, quantity, mix identification, admixtures, design slump, design density, aggregate size, design strength, time of batching, time of delivery, location of pour in building, quality, air temperature, and test samples taken. File duplicate copies of concrete delivery slips. Make these records available for inspection at all times.

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- .9 Testing Agency shall advise Contractor and Departmental Representative, without delay, of concrete in non-conformance with this Specification, and/or where rejection of the concrete is deemed warranted. Concrete shall be rejected by the Contractor if the specified requirements of CAN/CSA-A23.1 and this Specification are not met.
- .10 Permit access to the batching plant by the Testing Agency.

## **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal and the Waste Reduction Workplan.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate a cleaning area for tools to limit water use and runoff
- .4 Carefully coordinate the specified concrete work with weather conditions
- .5 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .6 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate safety precautions collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal. Dispose of all waste in accordance with applicable local, provincial and national regulations
- .7 Choose least harmful, appropriate cleaning method which will perform adequately

## **Part 2 Products**

### **3.1 MATERIALS**

- .1 Portland Cement shall conform to CAN/CSA-A3000-03, Type 10, or as otherwise indicated on Drawings, or in the Soil Report, from the same source for the entire project.
- .2 Where used, supplementary cementing materials, such as cementitious hydraulic slag, blended hydraulic cement and Pozzolanic mineral admixtures shall conform to CAN/CSA-A3000-03.
- .3 Water, fine aggregates, and normal density coarse aggregates shall conform to CAN/CSA-A23.1. Coarse aggregate size to meet the requirements of CAN/CSA-A23.1, Clause 4.2.3., and the drawings. Coarse aggregates for slab-on-grade to be 20mm (minimum) crushed stone.
- .4 Air-entrainment admixtures shall conform to ASTM C260;
- .5 Chemical admixtures shall conform to ASTM C494;



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- .6 Pozzolanitic mineral admixtures shall conform to ASTM C1017;
- .7 Superplasticizing admixtures shall conform to ASTM C494;
- .8 Non-shrink grout shall be premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, of pouring consistency, and containing not less than 50% by mass of cement and not more than 0.06% soluble chloride ion by mass of cement, with an expansion of not less than 0.04% at 28 days, capable of developing compressive strength of 50 MPa at 28 days.
- .9 Dry pack shall be premixed compound of non-metallic aggregate, cement and sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing a compressive strength of 50MPa at 28 days.
- .10 Membrane-Forming Curing Compound: chlorinated rubber resin formulation to meet specified requirements of CAN/CSA-A23.1 and to ASTM C309, Type I, subject to the approval of the Departmental Representative. Curing compounds are not to be used for slabs to receive a waterproofing membrane, traffic-resistant wearing course, surface sealers, ceramic tile or other bonded finishes.

### 3.2 CONCRETE MIXES

- .1 Prepare concrete mix designs, and be responsible for all mix design costs including related testing.
- .2 Base design on CAN/CSA-A23.1, Clause 4 to produce concretes having the 28 day compressive strengths and slumps specified on the structural drawings.

| LOCATION  | 28 DAY<br>STRENGTH     | SLUMP * | CLASS OF<br>EXPOSURE |
|---|------------------------|---------|----------------------|
| All concrete work in areas exposed to de-icing material | 35 MPa                 | 75      | C-1                  |
| Interior slabs on grade                                 | 25 MPa                 | 75      | N                    |
| Footings unless noted                                   | 30 MPa                 | 75      | N                    |
| Foundation walls  | 25 MPa                 | 75      | F-2                  |
| Suspended slabs & beams                                 | 30 MPa                 | 75      | N                    |
| Columns & shear walls (see drawings):                   | 25, 30 , 35<br>& 40 MP | 80      | N                    |
| Slab on steel joists or deck                            | 30 MPa                 | 50      | N                    |
| Retaining walls & exterior curbs                        | 35 MPa                 | 75      | C-1                  |
| Grout for new stirrups in existing ribs                 | 40 MPa<br>(non-shrink) | 75      | N                    |
| Pavements & Walks                                       | 32 MPa                 | 50      | C-2                  |
| Exterior concrete with rebar either exposed or not      | 35 MPa                 | 50      | C-1                  |
| Exterior concrete with no rebar either exposed or not   | 32 MPa                 | 50      | C-2                  |

\* Obtain these slumps with aid of specified water reducing agent.

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- .3 Concrete for slabs to receive resilient sheet flooring shall meet flooring manufacturer's requirements while providing adequate workability and compliance with specified slumps.
- .4 Design mix to meet the specified exposure requirements of CAN/CSA-A23.1, with the appropriate water/cement ratio and entrained air content given in Tables 1 to 9 of A23.1. Refer to Drawings for required design exposure classifications.
- .5 Concrete for all exposed work shall be of uniform colour and aggregate, and shall be to the approval of the Departmental Representative.
- .6 Only use admixtures which have been tested and accepted in mix designs. Obtain the approval of the Departmental Representative before using chemical admixtures, or supplementary cementing materials.
- .7 The use of calcium chloride or chloride-containing admixtures is strictly prohibited, for all concrete mixes.
- .8 Design concrete with normal rate of hardening. If advantageous to employ modified rates of hardening to facilitate Work and to improve workmanship, Departmental Representative may give approval for use of admixtures.
- .9 Where testing or inspection indicates excessive bleeding, segregation, poor workability of fresh concrete, or insufficient strength of hardened concrete, then mixes shall be redesigned to acceptable standards.
- .10 Submit, to the Departmental Representative and Testing Agency, in writing, proposed mix designs for each proposed concrete mix, at least 20 days prior to the start of work. Specify intended use for each mix design. Provide mix designs for both winter and summer concrete. Mix designs may be adjusted when job conditions or other circumstances warrant, provided revised mixes are submitted for review in the above manner. Failure to make the necessary submissions may be cause for the classification of the Work as being defective.
- .11 Proceed with concreting operations with the approved mix designs but if, at any time, tests of job concretes indicate failure to meet strength, slumps, density, air content and rate of hardening requirements, or if appearance is unacceptable, adjust the standard proportions to meet requirements. Advise Departmental Representative of changes to approved mix designs during progress of Work.

- .12 Use of Slag or fly ash as a partial replacement of cement shall be used as set out herein. The use of slag or fly ash shall be maximized as much as is practical for the project with the following considerations and restrictions:
- .1 Floor finishing must be able to commence 4 hours after the commencement of placing of concrete and must be able to be completed within an 8 hour time period or less.
  - .2 The strength of the concrete on site for suspended slabs must be at 75% of the specified strength at 3 days.
  - .3 The concrete shall have sufficient strength and stiffness to allow formwork for all vertical surfaces to be removed 24 hours after placing of concrete.
  - .4 The specified strength of the concrete on site for columns and shear walls must be reached at 56 days or less, unless otherwise noted.
  - .5 The amount of fly ash or slag must be adjusted for site temperature conditions at the time of placing of concrete to ensure that the requirements above can be met.
  - .6 The fly ash content for all C-1 concrete shall not exceed 20% replacement of cement.
  - .7 Submit for review the amount of fly ash or slag as a percentage of replacement of cement for each mix design.
  - .8 At the completion of the project, provide in writing the overall average of the percentage replacement of cement with the use of slag and/or fly ash for all concrete supplied for the project.
- .13 Polypropylene fibres: Where specified, add 1 kg/m<sup>3</sup>, in small quantities at plant, with minimum 7 minutes mixing time.

**3.3 ADDITIONAL CONCRETE MIX REQUIREMENTS FOR TRUCK DOCKS OR OTHER AREAS SUPPORTING VEHICLES**

- .1 All the provisions of Section 2.2 apply, except as provided below.
- .2 The provisions for concrete apply to all components of the structure, including footings, retaining walls, columns, suspended slabs, toppings on suspended slabs, and upstand beams.
- .3 Concrete mix for all components to include a calcium nitrate corrosion inhibitor applied at the rate of 10 l/m<sup>3</sup>.
- .4 Submit for review the name of types of calcium nitrate to be used and the proposed supplier.
- .5 For information only, the suspended floor slabs will have a membrane topping.

**Part 3      Execution**

**3.1          PREPARATION**

- .1 Obtain Departmental Representative's approval for planned sequence and form of communications before each concrete pour. See Clause 3.2.5 Placing of Concrete.
- .2 Pumping of concrete is permitted only after approval of equipment and mix.
- .3 Anchor reinforcement and inserts to ensure they will not be displaced during concrete placement.
- .4 Prior to placing of concrete obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .5 Do not place concrete prior to receiving written acceptance from the Departmental Representative of the weight of the mechanical and electrical equipment to be installed on the slab.
- .6 Plan locations of sawn control joints in slabs on grade and arrange to have equipment on site and ready to cut joints as soon as surface has hardened sufficiently to resist raveling. Place joints at 4.5m max spacing each way, unless otherwise noted on drawings. See CSA A23.1 Clause 7.3.2.
- .7 Sleeves and inserts.
  - .1 No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated or approved by Departmental Representative.
  - .2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 x 100 mm not indicated, on the structural drawings must be approved by Departmental Representative.
  - .3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Departmental Representative before placing of concrete. Provide additional reinforcing as directed.
  - .4 Check locations and sizes of sleeves and openings shown on structural, architectural and mechanical drawings. Report discrepancies to Departmental Representative for direction.
  - .5 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .8 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

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- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete. Place steel dowels of deformed steel reinforcing bars and pack solidly with shrinkage compensating grout epoxy grout to anchor and hold dowels in positions as indicated.
- .11 Where required, set anchorage devices for tie-back and life-line (roof) anchors, davit bases, or other window-washing anchor inserts, in accordance with manufacturer's instructions, and with reviewed shop drawings.
- .12 Dovetail anchor slots:
  - .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
  - .2 Install continuous vertical anchor slots at 800 mm c/c where concrete walls are masonry faced.
- .13 Dissimilar embedded metals shall be separated by a minimum of 40mm of concrete or shall be protected by electrically insulating coatings or separators, for all concrete in parking garage or concrete otherwise likely to be exposed to moisture. Stainless steel and plain steel shall be considered dissimilar metals.
- .14 In parking garage slabs and ramps, metallic embedment and inserts such as electrical & conduits, junction and fixture boxes, floor drains, pipes, and other hardware shall conform to CAN/CSA-S413.
- .15 Openings in concrete walls which are required for the installation of temporary shoring rakers are to be built as construction joints with keys. Remove raker by cutting flush with soldier pile, touch up with epoxy paint, and fill opening with concrete matching remainder of wall.
- .16 Obtain Geotechnical Authority's approval of foundation bearing surfaces for bearing capacity, depths, and dimensions, prior to placing concrete. Assist Geotechnical Authority as required. Maintain accurate records of as-built founding elevations, and submit record drawings to Departmental Representative.
- .17 For slabs-on-grade, obtain written approval of Geotechnical Authority prior to concreting that the underfloor drainage system (if required) has been satisfactorily installed, that compaction tests have been carried out and that any necessary recompaction has been completed.
- .18 Obtain Departmental Representatives review of conduit routing in slabs prior to placing concrete.

### **3.2 CONSTRUCTION**

- .1 Do cast-in-place concrete work in accordance with CAN/CSA-A23.1.
- .2 Do not place load upon new concrete until authorized by Departmental Representative.

.3 Slabs to receive resilient sheet flooring shall:

- .1 Have sealers and curing compounds compatible with flooring systems and acceptable to flooring manufacturer and installer,
- .2 Meet moisture and alkalinity requirements of the flooring manufacturer. Allow for "drying out" time acceptable to flooring manufacturer and installer. Carry out test patches to ensure that moisture content of slabs are compatible with flooring system and acceptable to flooring manufacturer and installer.

.4 Construction Joints

- .1 Provide construction joints in horizontal or vertical surfaces in accordance with CAN/CSA-A23.1, and as indicated on the Drawings.
- .2 Locate construction joints so as not to reduce the strength and appearance of the structure.
- .3 Unless noted, locate construction joints at high points in slabs
- .4 Unless noted, run reinforcement through construction joints, and form keys as indicated on the Drawings
- .5 Where vertical drainage system for foundation walls is indicated in the Soil Report, align vertical construction joints in foundation walls with drainage courses
- .6 Sawcut control joints in slabs-on-grade in accordance with Clause 3.1.5 (above) and the drawings.

.5 Placing of Concrete

- .1 Obtain Departmental Representative's approval of reinforcing placement before placing concrete. Provide Departmental Representative minimum 24 hours notice prior to placing concrete. Notify the Testing Agency in sufficient time to allow necessary tests or other preparatory work to be done. In slab construction, ensure all steel is in place and inspected before commencing concrete placement. Do not begin to place concrete until the work of other trades affecting concrete is complete. Failure to meet this requirement may be cause for classification of the Work as being defective.
- .2 Immediately before concrete placement, moisten all absorbent material that will be in direct contact with the fresh concrete. Take care to prevent ponding.
- .3 For concrete placed on metal deck or precast floor units, co-ordinate placement technique with deck supplier for strength and shoring requirements, so as not to damage the deck.
- .4 Place concrete in accordance with CAN/CSA-A23.1, under the supervision of a competent foreman at all times. Do not permit disapproved or rejected materials on the site.
- .5 Water, cement, aggregates or admixtures shall not be added to the concrete after the initial introduction of the mixing water to the batch.

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- .6 Concrete shall not be placed, if in the opinion of the Departmental Representative or Testing Agency, it cannot be placed and properly consolidated without the addition of any other water to the batch.
  - .7 In no case shall the time between batching and complete discharge of the concrete exceed 90 minutes.
  - .8 Concrete shall be completely placed within 30 minutes of leaving the transit mixer
  - .9 Ensure reinforcement and inserts are not disturbed during concrete placement and vibration.
  - .10 Place concrete in a continuous operation within planned construction joints. Deposit concrete as nearly as practicable to its final position to avoid segregation due to rehandling or flowing. Handle concrete from the point of delivery to the locations of final deposit as rapidly as practicable, using conveying methods which will prevent segregation or loss of concrete mix materials. Do not transport concrete using vibrators.
  - .11 Consolidate placed concrete using mechanical vibrators supplemented by hand-spacing, rodding or tamping. Vibrate concrete evenly and uniformly but limit the duration of vibration to the minimum time necessary to consolidate the concrete and to embed the reinforcing and inserts, without causing segregation.
  - .12 Do not allow vibrator to touch formwork. Take particular care to prevent formation of surface defects and honeycombing.
- .6 Hot/Cold Weather
- .1 Place concrete in cold weather as specified in CAN/CSA-A23.1, Clause 7.4.1.8. Protect concrete from physical damage or reduced strength due to premature drying or weather extremes.
  - .2 Carry out hot weather concreting in accordance with CAN/CSA-A23.1, Clauses 5.2 and 7.4, including use of approved moisture retention film, if applicable.
  - .3 De-icing chemicals shall not be used on the concrete formwork, or on the finished concrete.
  - .4 If rain or snow begins after concrete is placed, and before it is set, protect with waterproof covers until set.
  - .5 Obtain approval from the Departmental Representative and Testing Agency for proposed method for protection of concrete during placing and curing in adverse weather, prior to placing of concrete.
  - .6 To ensure that concrete cures without suffering damage, take precautions by protective methods, provision of heat, maintenance of humidity, free circulation of warm moist air at concrete surfaces, and other means made necessary by conditions that arise. Do not use unvented heaters.
- .7 Finishing, General
- .1 Finish concrete in accordance with CAN/CSA-A23.1.

- .2 Rub exposed sharp edges of concrete with carborundum to produce 3mm radius edges unless otherwise detailed.
  - .3 Refer to Architectural Drawings and Specifications for special finishes.
- .8 Finishing Slabs
- .1 General:
    - .1 Finish concrete floor slabs to CSA-A23.1 Clause 7.5.1 and Table 22 for Class A buildings, unless otherwise indicated.
    - .2 Use procedures acceptable to Departmental Representative and those noted in CAN/CSA-A23.1 to remove excess bleed water. Ensure surface is not damaged
    - .3 Steel trowel slabs to be left exposed or to receive flooring or carpeting.
    - .4 Other slabs to be screened off to true lines and levels and left ready to receive specified finish. Depress slabs where required and/or indicated.
    - .5 Ensure that floor drains are located at low points so that no ponding will occur. Where floor drains occur, floors to be leveled around the walls and have a minimum 5mm per meter (0.5%) uniform pitch to drains, unless indicated otherwise.
    - .6 Apply non-metallic surface hardener to exposed concrete floors in accordance with Section 03 35 05.
    - .7 Use curing compounds compatible with applied finish on concrete surfaces.
  - .2 Plain Floor Finish (Unexposed):
    - .1 Roll or tamp concrete to force coarse aggregate into concrete mix, then screed.
    - .2 Float surface with wood or metal float or with power finishing machine and bring surface to true elevation.
    - .3 Steel trowel to smooth and even surface.
    - .4 Follow with second steel trowelling to produce smooth burnished surface to within 8mm tolerance when measured in any direction using 3m straight edge, unless noted otherwise. Do not overtrowel.
    - .5 Sprinkling of dry cement or dry cement and sand mixture over concrete surfaces is not acceptable.
    - .6 Apply curing compound in accordance with manufacturer's instructions. Do not use curing compound when slab is to receive bonded finish. Wet curing for a minimum of seven days with burlap and polyethylene over shall then be employed.
    - .7 Sawcut crack-control joints in slabs on grade to CAN/CSA-A23.1 (maximum 24 hours after placement), or as noted on drawings. Fill joints with joint sealant as applicable.



- .8 After curing and when concrete is dry, fill control joints and joints at junction with vertical surfaces with weak cementitious grout.
- .3 Floor Finish (exposed):
  - .1 Finish concrete floors as per Paragraph 3.2.8.2, Clauses .1 to .5, and apply floor hardener, non-metallic aggregate at a rate of 3.5 kg/m<sup>2</sup> to manufacturer's instructions.
  - .2 Apply approved curing/sealing compound to manufacturer's instructions, except for slabs on grade and garage slabs, which shall be wet cured for a minimum of seven days with burlap and polyethylene over.
  - .3 Sawcut crack-control joints in slabs on grade to CAN/CSA-A23.1-04 (maximum 24 hours after placement), or as noted on drawings. Seal with joint filler.
  - .4 After curing/sealing and when concrete is dry, seal control joints and joints at junction with vertical surfaces with sealant.
  - .5 Clean surfaces and apply second coat curing/sealing compound before handing building over to Departmental Representative.
- .9 Toppings.
  - .1 Topping mixture to meet following requirements:  
Monolithic, mm thick: 50  
Bonded overlay, mm thick: 100.
  - .2 In pouring base course, make allowance for monolithic and bonded overlay topping thickness
  - .3 Place monolithic topping before base course has completely set in accordance with CAN/CSA-A23.1 and topping manufacturer's recommendations
  - .4 Place bonded topping over hardened base course in accordance with CAN/CSA-A23.1 and topping manufacturer's recommendations.
  - .5 Follow instructions by Departmental Representative in case conflicting requirements arise between CAN/CSA-A23.1 and manufacturer's recommendations
  - .6 Apply cement/sand grout latex bonding agent modified cement/sand grout epoxy bonding agent to base course in accordance with CAN/CSA-A23.1 and manufacturer's recommendations before placing bonded topping. Observe manufacturer's safety recommendations.
  - .7 Ensure that joints in topping are of the same as those in base course. Also ensure that their locations precisely match those in base course. Provide dividers edge strips reinforcing mesh as indicated

### **3.3 FORMWORK REMOVAL AND RESHORING**

- .1 Refer to Section 03 10 00 for specified requirements.

### **3.4 CURING**

- .1 Cure concrete as specified in CAN/CSA-A23.1 and in Section 03 35 00.
- .2 Do not use curing compounds that would have a detrimental effect on bonding, adhesion, curing, appearance, or similar qualities of materials to be applied to concrete surfaces. Use only moisture curing (wet burlap with polyethylene sheeting) at a temperature of at least 10°C for surfaces where applied coatings or finishes are incompatible with curing compound, and maintain continuously moist for a minimum of 7 days.

### **3.5 ARCHITECTURAL CONCRETE**

- .1 Architectural concrete is concrete which will be permanently exposed to view in interior finished areas and on unclad portions of building exterior. Final appearance is as important a factor as the engineering properties of the concrete and failure of the as-cast concrete to meet the required standard of appearance may be a cause for rejection.
- .2 Ensure that exposed surfaces are dense, even, uniform in colour, texture and distribution of exposed aggregate. They shall be free from defects such as honeycombing, voids, loss of fines, visible flow lines and cold joints. Defects of this nature shall be cause for rejection of the Work.
- .3 Ensure that concrete members have sharp accurate definitions of corners, reglets, etc. and are free from chips and spalls.
- .4 Protect finished Work from damage and staining during the construction period. Pay special attention to the protection of projecting reinforcing at construction joints.

### **3.6 OTHER CONCRETE**

- .1 Provide electrical and mechanical equipment bases and toppings including floating slabs and toppings, isolation pads, inertia bases and other concrete pads, as required.
- .2 Provide mechanical sump pits and electrical manholes, as cast in place concrete.
- .3 Provide concrete bases for exterior lighting fixtures and other landscape features, and for buried electrical duct banks.

- .4 Unless otherwise detailed, form curbs around duct shafts, electrical shafts, pipe shafts and other floor openings for mechanical and electrical services in sprinklered and parking areas. Curbs shall be minimum 150mm wide, 100mm high, with coved bases and chamfered corners or as otherwise detailed on the Drawings. Finish with steel trowel. Unless otherwise shown on the Drawings, reinforcing shall be one 15M longitudinal bar, with 10M dowels from supporting floor slab at 400mm centres. Where curb height exceeds 400mm, provide 1-10M additional horizontal bar at mid-height.
- .5 Provide any additional cast-in-place concrete required under the work of Divisions 22, 23 and 26, but not stated above.
- .6 Refer to Mechanical, Electrical and Architectural drawings for miscellaneous concrete not indicated on structural drawings.
- .7 Provide concrete fill in landings and stair pans, for metal stairs required under the Work of Division 05.

### **3.7 CONCRETE FOR LANDSCAPING**

- .1 For exterior landscaping concrete, either exposed or not, if reinforcing steel is present, provide C-1 concrete with calcium nitrate additive and epoxy coated reinforcing steel.
- .2 For exterior landscaping concrete, with no reinforcing steel, concrete shall be C-2. If the concrete is not visually exposed, provide poly-fiber reinforcement.

### **3.8 GROUTING AND PATCHING**

- .1 Grout underside of steel column and beam bearing plates with specified non-shrink type grout to Manufacturer's instructions. Provide 100% contact over grouted bearing areas.
- .2 Touch up concrete foundation walls following removal of raker/tieback system, ensuring that patching method precludes penetration of water or corrosion products into the finished building, in a manner acceptable to the Departmental Representative.
- .3 Where new construction abuts or adjoins existing structure(s), grout joints between new and existing framing, unless shown otherwise on the Drawings.
- .4 Take necessary precautions to ensure good bond of grout to substrate and to exclude entrapped air from grouted joints.

**3.9 DEFECTIVE CONCRETE**

- .1 Remove damage, discoloured or defective concrete, blemishes, honeycombing, excessive laitance and embedded debris as directed by Departmental Representative.
- .2 Where the results of specified concrete tests indicate non-compliance with the requirements of this Specification, or where such tests have not been carried out, or when conditions exist such as to cause doubt about the safety, serviceability or durability of the structure, or part thereof, the Departmental Representative shall have the right to order non-destructive testing, and/or field coring for supplementary testing. Such additional tests (including patching of core holes) shall be made at no cost to the Contract.
- .3 Contractor shall submit in writing, details of proposed method of remedial work, for approval by Departmental Representative.
- .4 Where deemed necessary, doweling of reinforcing into hardened concrete shall be by the "Hilti HIT technique" or approved alternate.
- .5 Defects shall be repaired at no cost to the Contract.

**END OF SECTION**