



APPENDIX A
Concrete Specification

Concrete Formwork and Falsework

PART 1 - GENERAL

1.1 Work Included

- .1 Read and be governed by Conditions of the Contract and Sections of Division 1.
- .2 The specification includes specific requirements applicable to the use of High Volume Supplementary Cementing Materials (HVSCM) concrete. For ease of reference, these clauses are indicated in **bold**. HVSCM Concrete must comply with these specific requirements and all other specification clauses.
- .3 Provide all labour, materials, plant and equipment to complete the concrete formwork and falsework indicated on the drawings and specified herein.

1.2 Related Work Specified Elsewhere

- .1 Concrete Reinforcement, Section 03200.
- .2 Cast-in-Place Concrete, Section 03300.
- .3 Concrete Floor Finishes, Section 03345.
- .4 Structural Steel, Section 05120, for anchor assemblies, bolts and the like to be cast into concrete.

1.3 Reference Standards, Codes And Acts

- .1 Conform with the Ontario Building Code Regulations 403/97 as amended by O.Reg. 22/98, 102/98, 122/98, 152/99, 278/99, Minister's ruling 99-BC-01, 593/99, 597/99, 205/00 and 283/01 and any applicable acts of any authority having jurisdiction and the following:
 - .1 A23.1-94 Concrete Materials and Methods of Concrete Construction.
 - .2 A23.2-94 Methods of Test for Concrete.
 - .3 ACI 228R-95 In-Place Methods to Estimate Concrete Strength
 - .4 O86.1-94 Engineering Design in Wood (Limit States Design).
 - .5 CAN/CSA-O325.0-92 Construction Sheathing.
 - .6 CSA S269.1-1975 Falsework for Construction Purposes.
 - .7 CSA S269.3-M92 Concrete Formwork.
 - .8 Ontario Provincial Standard Specification (OPSS) 1308 Material Specification for Joint Filler (Concrete).

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- .2 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.
- .3 Standards referenced by the Standards noted above are to apply even if they are not included in the list.

1.4 Tolerances

- .1 Perform forming operations and place hardware so that finished concrete will be within the tolerances set out in A23.1.
 - .1 Variations in building lines which result in extension of the building over lot lines or restriction lines will not be permitted.
 - .2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.5 Design

- .1 Formwork , Falsework and Reshoring.
 - .1 Design formwork and reshoring to safely support vertical and lateral loads until they can be supported by the structure. Design formwork for loads and lateral pressures recommended in CSA S269.1.
 - .2 The falsework design shall be by a qualified Professional Engineer licensed in the Province of Ontario with demonstrated competence in the design of such temporary construction facilities.
 - .3 Design and provide shoring and bracing to excavations to safely withstand any lateral pressures to which they may be subjected.
- .2 Bearing Assemblies
 - .1 General
 - .1 Design bearings so that they conform to the configurations shown and can safely transmit the loads and permit the movements noted.

1.6 Architectural Concrete

- .1 Quality of Finish:
 - .1 The quality of finish shall be such that, when the forms are stripped, it meets the standards set out below without further finishing work other than clean-up.

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- .2 Dense, even concrete, free of major defects such as deep or extreme honeycombing, inconsistencies in plane, severe cold joint lines and major loss of fines. Minor imperfections may be acceptable. Major defects will necessitate replacement. The judgment as to what constitutes major or minor defects will be the Consultant's alone. Patching is not permitted and if used will constitute a major defect. Repairs, i.e. removal of sections of a member, may be carried out if approved by the Consultant, but the repair shall match the colour and texture of the surrounding concrete.
 - .3 Concrete members of generally uniform colour.
 - .4 Concrete members with sharp, accurate definition at corners, arises and reglets generally free of chipped or spalled areas and within dimensional tolerances set out in A23.1 and A23.2. Members shall be visually straight.
 - .5 Plane surfaces without protuberances, indentations, ridges or bulges.
 - .6 Under no circumstances shall repair to any architectural concrete be undertaken without the Consultant's written consent. Concrete members which are repaired without the Consultant's consent will be classified as defective Work and the Consultant may require their removal and replacement.
- .2 Approved Surfaces
- .1 Approved areas of architectural concrete of the surface quality required have been designated by the Consultant at The Gerstein Science and Information Centre, University of Toronto as follows:
 - (a) Finish of concrete column, beams and shear walls is to be smooth and even colour.
 - (b) All corners of columns, beams and shear walls are to be 90 degrees. Chamfering corners is not permitted.
 - (c) Reglets between pours of concrete are to be 9.5 mm by 9.5 mm.
 - .2 View these approved areas prior to tendering and during construction employ necessary methods and procedures to achieve surfaces of at least equal quality.
- .3 Samples and Assistance
- .1 General
 - .1 Supply samples of all materials and the following, the cost of which shall be paid for by this trade.

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- .2 Show method and schedule of construction, materials, arrangement of joints, ties, shores, liners and locations of temporary embedded parts.
- .2 Sample Panels/Areas - Architectural Concrete Forms
 - .1 Well in advance of constructing architectural concrete, to prove out the materials and procedures proposed, construct a sample section of each type of architectural concrete utilizing portions of the concrete structure not exposed to view in the finished building. The samples are to include as a minimum 2 circular columns, a 5 m length of concrete wall and a 5 m x 5 m area of exposed concrete floor finish.
 - .2 If the sample panels do not meet the minimum standards specified it may be necessary to construct additional samples, again utilizing portions of the structure to be concealed. The quality of the approved samples along with the criteria specified shall be the minimum standards for architectural concrete.
- .3 Submit two pieces 1 metre square of the plywood specified for smooth architectural concrete.
- .4 Submit form tie and corner tie.
- .5 Submit sample of form joint sealer and caulking to be used in form construction.
- .6 1 metre section of Sonotube form and liner.

1.7 Submittals

- .1 Shop Drawings for Formwork, Falsework and Reshoring
 - .1 The structural drawings shall not be reproduced, in whole or in part, for use as shop drawings.
 - .2 Well in advance of construction, submit to the Consultant drawings showing the complete design of the slab formwork, falsework and reshoring systems stamped by a qualified Professional Engineer licensed in the Province of Ontario.
 - .3 As a minimum, show the following:
 - .1 stripping schedule;
 - .2 sequence for installing reshores;
 - .3 number of slabs reshored at any given time;

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- .4 formwork details related to stripping and reshoring; and
- .5 formwork for architectural concrete.
- .4 Submit a written proposal for review by the Consultant as to how the specified cambers are to be achieved, in the field.
- .2 Opening information
 - .1 Submit drawings of the structure showing formed holes, recesses and sleeving required under all Sections.
- .3 Surveys
 - .1 Submit surveys showing position of formwork, cast-in-place inserts and structural elements in their as-built condition.
 - .2 As a minimum include the following:
 - 1. Elevation and location of centreline with respect to grids of all footings;
 - 2. Location of centreline of all columns with respect to grids at each floor level;
 - 3. Location with respect to grids and horizontal alignment of all concrete walls at all floor levels;
 - 4. Vertical alignment (plumbness) of all columns and walls at all floor levels;
 - 5. Elevation of slab formwork and slabs at all columns, walls, centre of bays, midway between columns along gridlines and at cantilever ends, at points of maximum camber on all floor levels at the following times:
 - a. Before concrete placement.
 - b. After concrete placement, prior to removal of any formwork and reshores from below.
 - c. Between 7 and 14 days after removal of all reshores immediately above and below the subject floor.
 - 6. Location and alignment of edge of slabs with respect to grids at all floor levels;
 - 7. Location and elevation of cast-in-place hardware at all levels;

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8. All surveys submitted must clearly indicate the date when the survey was actually carried out;
 9. Regular elevation checks of formwork adjacent to shrinkage strips.
- .4 Sloping Slabs
- .1 Well in advance of construction, submit complete details of forming together with placing and compaction procedures for sloping slabs, including details of construction and placing of top forms and top form panels.
- .5 As-Built Drawings
- .1 Mark on a complete set of final reproducible drawings any changes, additions or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reason.
 - .2 Bearing Assemblies
 - .1 Submit shop drawings and technical specifications for the bearing assemblies to the Consultant.

PART 2 - PRODUCTS

2.1 Materials

- .1 Forms
 - .1 Formwork lumber: plywood and wood formwork materials shall conform to O86.1 and CAN/CSA - O325.0.
 - .2 Falsework materials: conform to CSA S269.1.
 - .3 Sheathings for exposed surfaces: New, Douglas Fir Plywood not less than 18 mm thick, concrete form grade, sanded one side, conforming to CAN/CSA-O325.0.
- .2 Dovetail anchor slots: minimum 0.6 mm thick galvanized steel with insulation filled slots.
- .3 Waterstops:
 - .1 Construction and Control Joints: Provide Durajoint Type 7 (internal type) or Sternseal Type 69 (external type) as manufactured by Sternson Construction Products or approved alternative.
 - .2 Expansion Joints: Provide Durajoint Type 7C (internal type) or Sternseal Type 79 (external type) as manufactured by Sternson Construction Products or approved alternative.

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- .4 Expansion Joint Filler: Sternboard by Sternson Construction Products or approved alternative.
- .5 Architectural Concrete Form Materials
 - .1 Circular column forms: Sonotube, seamless fibre forms as manufactured by Sonoco Products Company or approved alternative.
 - .2 Circular column capitals: Sheet metal of a minimum 14 gauge thickness of 1.9 mm. Supply capital form with no more than two side joints and joint edges shall be suitably stiffened with angles to prevent distortion. Form joints shall fit accurately and be grout tight. Capital shall be formed with flanges at the base, where the capital fits into the column form and at the junction of the capital and the slab. The base flange shall not exceed a width of 25 mm. All metal jointing shall be done by welding.
 - .3 Reglet material at the junction of circular columns and capitals: Neoprene, unicellular foam. Cement in place. Neoprene shall be sufficiently stiff so that it does not deform during concreting.
 - .4 Plywood sheathing for smooth concrete and concrete to be sandblasted: Evans 107 Plywood at least 17 mm thick, or approved alternative.
 - .5 Grooves or reglets: White pine dressed to exact size.
 - .6 Form Ties: Williams Shebolt, or approved alternate, threaded internal disconnecting-type adjustable in length. Ties shall be designed to act as spreaders and be of such a type that when the external portion of the tie is removed, no metal is left closer than 40 mm to the surface. Maximum diameter of external portion of the tie shall be 12.5 mm.
 - .7 At all vertical outside corners of forms for walls, balustrades, piers and the like, use continuous threaded coil and corner ties with associated corner brackets and coil wing nuts.
 - .8 Form Release Agent: Form release agent to be waterborne, non-staining and non-grain raising subject to approval by the Consultant.

PART 3 - EXECUTION

3.1 Concrete Work At Existing Structure

- .1 Before proceeding with any work in or adjacent to the existing structure, verify that conditions are as indicated on the drawings. If they are not, do not proceed until the Consultant has given instructions.

3.2 Formwork

- .1 General

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- .1 Erect, support, brace, and maintain formwork to safely support vertical and lateral loads until they can be supported by the structure.
 - .2 All falsework erection shall be supervised by the Professional Engineer responsible for its design.
- .2 Construction
- .1 Form footing sides unless footings are shown to be placed against undisturbed soil.
 - .2 Where shown, camber formwork such that hardened concrete, prior to stripping of forms, is cambered as shown. Maintain beam depth and slab thickness from cambered surface.
 - .3 Camber slabs and beams 1 in 500 of span unless shown otherwise.
 - .4 Mark building, grid or other lines on forms to permit the accurate positioning of reinforcing steel.
 - .5 Construct templates and supports to rigidly fix reinforcing dowels in the forms prior to concreting.
 - .6 Provide suitable markers to indicate the location and configuration of continuing concrete members so that dowels can be positioned accurately in relation to their position in the continuing members.
 - .7 Set anchor bolts, templates, steel connection units, hardware, or other inserts into the forms and secure them rigidly so that they do not become displaced during concreting. Set and secure these items to the tolerances specified and required in the appropriate Sections.
 - .8 Build top forms on sloping concrete where required to prevent flow of the concrete out of the forms.
 - .9 In the case of sloping slabs employ suitable forming procedures compatible with the concrete placing and compaction techniques to ensure that completed concrete has the specified design characteristics. In particular, prevent movement of plastic concrete resulting in cracking, loss of bond, etc., and achieve a surface equivalent to a fine wood float finish suitable to receive a membrane.
- .3 Sleeves, Chases and Formed Openings
- .1 Form sleeves, chases and openings except where such items are specified to be formed or sleeved by the appropriate trade.
 - .2 All openings, sleeves, chases are not necessarily shown on the structural drawings nor are their sizes or locations shown. Refer to architectural,

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mechanical and electrical drawings and specifications for openings and sleeving requirements not shown, located and dimensioned on the structural drawings.

- .3 No sleeves, chases and openings through structural members shall be formed without the Consultant's approval.
- .4 Exposed Concrete Forms
 - .1 Make joints of forms sufficiently tight to prevent leakage of concrete fines at corners of exposed beams, walls and columns or at the corners of exposed edges of slabs, and other concrete exposed to view in the finished building.
 - .2 Provide 20 mm V-joints at control joints.
 - .3 Form panels for exposed concrete may not be reused if surface is damaged or patched.

3.3 Architectural Concrete

.1 Formwork

- .1 Construct forms for architectural concrete so that they are grout tight at corners, panel joints, construction joints, arrises and recesses and so that concrete surfaces that are shown to be plane are plane and correctly aligned without indentations or protuberances other than those shown.
- .2 Construct butt joints between form ply panels as laid out on architectural drawings.
- .3 Use straight lumber making an accurate tight fit.
- .4 Seal, tape or caulk form panel joints.
- .5 Solidly back all joints between sheathing panels and tightly secure panels thereto.
- .6 Employ corner ties at all external corners.
- .7 Construct side forms for balustrades, sills, upstand beams and the like to the exact height of the member. Align the top edges of the forms to the correct elevation or slope so that the tops of the members can receive a fine wood float finish to a straight line.
- .8 In walls and the like, provide suitable spaced clean-out doors at the bottom of the forms. Place the doors, if possible, in the side of the member, which is not exposed. Where this cannot be arranged accurately, construct clean-out doors and install so as to leave no indentations or protuberances and to prevent concrete leakage.

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.2 Form Ties

- .1 Align ties on a particular member both vertically and horizontally.
- .2 Form tie spacing is typically 1200 mm and as shown on architectural drawings.
- .3 Ties shall not be placed horizontally closer than 300 mm to a corner, or at an edge of an opening, or to a vertical reglet nor vertically closer than 150 mm to an edge of an opening or to a horizontal reglet. The tie pattern shall be symmetrical and to the Architect's approval.
- .4 Install ties at right angles to the form in tight fitting holes to prevent concrete leakage. Where re-use of forms is permitted, arrange so that tie holes are also re-used. All form ties, particularly at corners and construction joints, shall be fully tightened so as to eliminate leakage of concrete fines.

.3 Walls, Columns and Deep Beams:

- .1 Studs shall be carefully plumbed and not spaced over 400 mm on centre. Reduce spacing to 300 mm where the grain of the outer plies is parallel to the studs. Walers shall consist of two members and the joints in the top and bottom members shall be staggered at least the spacing of the form ties. Walers shall not be spaced more than 600 mm on centre and ties not less than 1200 mm on centres.
- .2 For forms 6 m or more in height, double 50 mm x 150 mm vertical walers spaced not more than 3 m on centres and extended the full height of the forms shall be bolted to every other set of horizontal walers to maintain the forms in straight and true alignment.
- .3 Forms for duct openings, sills and the like shall be removable to permit access for concrete placing and vibration.
- .4 Braces or shores through exposed faces of walls will not be permitted.

.4 Smooth Concrete:

- .1 Form surfaces generally with full-sized plywood sheets. Panel arrangements shall be as shown or to the Consultant's approval.
- .2 Provide 90 degree corners at all external vertical and horizontal corners on the interior and exterior of the building.
- .3 Provide as per architectural drawings for exterior concrete, reglets at all butt joints between form panels, construction joints and control joints. Seal form panel joints with caulking prior to installing reglets.

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.5 Smooth Concrete soffits:

- .1 Form slab and stair soffits generally with full-sized plywood sheets with joint layout shown or approved by the Consultant.
- .2 Coordinate with other trades and provide protection to slab forms as required to prevent damage or staining during the work of other trades.

.6 Circular Columns:

- .1 Prior to concreting, rigidly support circular column forms at base, mid-height and top of column and install reglet as shown.

.7 Construction Joints in Walls:

- .1 Horizontal joints will be permitted at locations approved by Consultant. Build forms to finish flush with the top of construction joints to permit trowelling the surface to accurate alignment. Install and securely fix reglets as shown.
- .2 Vertical construction joints will only be permitted at locations approved by the Consultant. Construct the bulkhead in a manner which will prevent leakage of concrete fines.
- .3 When erecting forms for the continuing concrete, use a system where the forms, including reglets from the pour below remain in place, undisturbed for the pour above.

.8 Construction Joints in Other Members:

- .1 Construction joints will be permitted only at the locations shown, or where not shown, only at locations approved by the Consultant. Provide reglets in all construction joints as shown or where directed by the Consultant unless a construction joint without reglets is specifically called for on the drawings.

.9 Tolerances:

- .1 Construct forms for architectural concrete so that all concrete surfaces exposed to view will be visually straight.

.10 Release Agent:

- .1 Coat surface of forms to be in contact with concrete with an approved material which provides complete bond-breaking action. Apply surface treatment strictly in accordance with manufacturer's instruction. Re-coat surface of forms after use as necessary.

.11 Stripping of Forms:

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- .1 Forms for architectural concrete shall not be stripped until at least 7 days after concrete is poured. Take particular care when stripping to ensure that no damage occurs at corners, arrises or the like.
 - .2 To help avoid colour variation, the length of time between pouring and stripping shall be approximately the same for each portion of the Work.
- .12 Re-Use of Forms:
- .1 Thoroughly clean forms and treat with the parting agent as required before re-use.
 - .2 Forms may not be re-used if they are damaged in any way, which will leave blemishes on the finished surface. Also, they may not be re-used if the original tie holes are not re-used.

3.4 Stripping of Forms and Reshoring

- .1 For HVSCM Concrete do not strip forms from horizontal or sloping members until they have achieved a minimum of 70% of their specified 56 day strength. Where forms are stripped from horizontal or sloping members before concrete has reached its specified 28 day or 56 day strength, reshore the members so that they can safely support their own load plus construction loads. In addition, ensure that the stripped member is of sufficient strength to safely carry its own weight over the area stripped out at any instant, together with any superimposed construction loads.
- .2 As a minimum conform to requirements of S269.1 and the following:
 - .1 Reshores in the lower storeys shall be capable of safely carrying the full weight of the concrete and formwork posted to them prior to the removal of the first storey of shores supported by the ground or slab on grade.
 - .2 After reshores are removed from the first storey, the design and provision of reshores may be based on the assumption that each shored or reshored flexural member shares load in relation to its achieved strength, provided the flexural member has attained at least 70% of its specified 28 day or 56 day strength.
 - .3 Install reshores so that they are supported on members, which can safely support the reshore load.
 - .4 As a guide, for conventional concrete mixes under specified curing conditions, 70% of the 28 day strength should be attained 7 days after concreting in normal weather and 14 days after concreting in "Cold Weather". **High Volume Supplementary Cementing Materials (HVSCM) Concrete may have a slower strength gain.**
 - .5 Base decision to strip forms upon satisfactory results of 7 day concrete cylinder tests and on site curing conditions. **For HVSCM Concrete, base**

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decision to strip forms upon satisfactory results of pull out tests and on site curing conditions.

- .6 Stripping and reshoring shall proceed simultaneously so as not to leave an area greater than 9 square metres unsupported by either formwork or reshoring at any instant. Install reshores tight to construction above and below so that they will not significantly shorten under load, but take care not to preload the construction below or raise the construction above by over-tightening.
- .7 Maintain reshoring or formwork in place for a minimum of 28 or 56 days or for such longer time as may be required to ensure that the concrete has reached its specified 28 day or 56 day strength respectively.
- .8 Do not strip within one and a half bays of a construction joint until new concrete beyond the construction joint has reached 70% of its specified 28 day or 56 day strength.
- .9 Provide and install adequate shoring to safely support horizontal or inclined members after the 28 day or 56 day specified strength is achieved where superimposed loads exceed design loads.
- .10 Side forms for vertical members may be stripped as soon as the concrete is sufficiently strong to stand unsupported and safely resist imposed loads.

3.5 Construction Joints

- .1 Obtain approval from the Consultant for location and details of construction joints not shown.

3.6 Expansion and Control Joints

- .1 Construct expansion and control joints at the locations indicated and in accordance with the details shown.
- .2 Construct clean expansion joints free of foreign material, likely to impair the proper operation of the joint.
- .3 Provide a non-extruding joint filler in expansion joints for the full area between adjacent concrete members. Anchor the filler material to one of the adjacent members or between concrete members and adjacent members of other materials.
- .4 Where shown, provide waterstops in expansion joints.

3.7 Waterstops

- .1 Install waterstops to provide continuous water seal. Do not distort or pierce waterstop to hamper performance. Do not displace reinforcement when installing waterstops. Tie waterstops rigidly in place.

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- .2 Splice in accordance with the manufacturer's printed instructions and as follows. Only straight heat sealed butt joints permitted in field. Shop weld corners and intersections.
- .3 Where waterstops are noted to be installed into existing work, sawcut appropriately sized slots into the existing work and grout waterstops into the slots. Make waterstops continuous for the full length of the joint. Splice waterstops so that the waterstopping action will not be interrupted.

3.8 Bearing Assemblies

- .1 Remove laitance from the top surface of the bearing ledge and finish with a steel trowel to a dense level surface, to the elevations shown.
- .2 Place the bearings in the location required, ensure that they are solidly bedded on the ledge, are set level, and are secured in position.

3.9 Separation Strips

- .1 Provide separation strips where shown on the drawings. Maintain bays containing separation strips and each adjacent bay fully formed and shored until the strip is complete, and has reached its 28 day specified strength. Ensure that the forms and shores are designed so that no settlement of the forms occur during the period that the strip is open.

3.10 Quality Control

- .1 Implement a system of quality control to ensure that the minimum standards specified herein are attained.
- .2 Bring to the attention of the Consultant any defects in the work or departures from the Contract Documents, which may occur during construction. The Consultant will decide upon corrective action and give recommendations in writing.
- .3 The Consultant's general review during construction and inspection and testing by Independent Inspection and Testing Companies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.11 Notification

- .1 Prior to commencing significant segments of the work, give the Consultant and Independent Inspection and Testing Companies appropriate notification so as to afford them reasonable opportunity to review the work. Failure to meet this requirement may be cause for the Consultant to classify the work as defective.

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3.12 Inspection and Testing

- .1 The Owner will appoint an Independent Inspection and Testing Companies to make inspections or perform tests as the Consultant directs. The Independent Inspection and Testing Companies shall be responsible only to the Consultant, and shall make only such inspections or tests as the Consultant may direct.
- .2 Install pullout inserts where directed by the Owner's Inspection and Testing Company

3.13 Defective Materials and Work

- .1 Where evidence exists that defective work has occurred or that work has been carried out incorporating defective materials, the Consultant may have tests, inspections or surveys performed, analytical calculations of structural strength, made and the like, in order to help determine whether the work must be corrected or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the work may be acceptable.
- .2 All testing shall be conducted in accordance with the requirements of the Ontario Building Code, except where this would, in the Consultant's opinion, cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or work which fail to meet specified requirements may be rejected by the Consultant whenever found at any time prior to final acceptance of the work regardless of previous inspection. If rejected, defective materials or work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 03100

Cast-in-Place Concrete

PART 1 - GENERAL

1.1 Work Included

- 1.1.1. Read and be governed by Conditions of the Contract and Sections of Division 1.
- 1.1.2. The specification includes supplementary clauses applicable to the use of High Volume Supplementary Cementing Materials (HVSCM) concrete. For ease of reference, these clauses commence with the term "HVSCM Concrete" and are indicated in **bold**. HVSCM Concrete must comply with these specific requirements and all other specification clauses.
- 1.1.3. Provide all labour, materials, plant and equipment to complete the cast-in-place concrete work indicated on the drawings and specified herein.

1.2 Related Work Specified Elsewhere

- .1 Concrete Formwork and Falsework, Section 03100.
- .2 Concrete Reinforcement, Section 03200.
- .3 Concrete Floor Finishes, Section 03345.
- .4 Lifting of structural steel plates for inspection of grouting, Section 05120.

1.3 Reference Standards, Codes and Acts

- .1 Conform with the Ontario Building Code Regulations 403/97 as amended by O.Reg. 22/98, 102/98, 122/98, 152/99, 278/99, Minister's Ruling 99-BC-01, 593/99, 597/99, 205/00 and 283/01, any applicable acts of any authority having jurisdiction and the following:
 - .1 Ontario Provincial Standard Specification (OPSS) 1303 Material Specification for Air Entraining and Chemical Admixtures for Portland Cement Concrete.
 - .2 A23.1-94, Concrete Materials and Methods of Concrete Construction.
 - .3 A23.2-94, Method of Test for Concrete.
 - .4 A23.3-94, Design of Concrete Structures.
 - .5 A 3000-98 Cementitious materials Compendium.
 - .6 ASTM C900-94 Test Method for Pullout Strength of Hardened Concrete.

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.7 ACI 228.1R-95 In-place Methods to Estimate Concrete Strength.

.8 ANSI/ACI 347R-88 or CAN/CSA -S269.3-M92 Concrete Formwork.

.2 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

.3 Standards referenced by the Standards noted above are to apply even if they are not included in the list.

1.4 Tolerances

.1 Perform placing operations so that completed work will be within the tolerances set out in A23.1.

.2 Variations in building lines, which result in extension of the building over lot lines or restriction lines will not be permitted.

.3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.5 Architectural Concrete

.1 Quality of Finish: The quality of finish shall be such that, when the forms are stripped, it meets the standards set out below, without further finishing work other than treatment of tie holes, sandblasting as required, and clean-up. This requirement is waived for smooth concrete to receive a paint finish, in which case grinding of joints and filling of voids will be permitted.

.2 Dense, concrete finishes free of defects such as deep or extreme honeycombing, inconsistencies in plane, cold joint lines and loss of fines. Minor imperfections may be acceptable. Major defects will necessitate replacement. The judgement as to what constitutes major or minor defects will be the Consultant's. Patching will not be permitted and if used, will constitute a major defect. Repairs, i.e. removal of sections of a member, may be carried out if approved by the Consultant, but the repair shall match the colour and texture of the surrounding concrete.

.3 Concrete finish shall be uniform in colour.

.4 Concrete finishes shall exhibit sharp, accurate definition at corners, arrises, reglets and the like, generally free of chipped or spalled areas and within dimensional tolerances set out in A23.1. Members shall be visually straight.

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- .5 Plane surfaces without protuberances, indentations, ridges or bulges.
- .6 Sandblasted surfaces shall have uniform depth of cutback, distribution of aggregate and colour and texture matching the sample panel designated by the Consultant.
- .7 Under no circumstances shall repair to any architectural concrete be undertaken without the Consultant's written consent. Concrete members which are repaired without the Consultant's consent will be classified as defective and the Consultant may require their removal and replacement.
- .8 Approved Surfaces
 - .1 Approved areas of architectural concrete of the surface quality required have been designated by the Consultant at The Gerstein Science and Information Centre, University of Toronto as follows:
 - (d) Finish of concrete column, beams and shear walls is to be smooth and even colour.
 - (e) All corners of columns, beams and shear walls are to be 90 degrees. Chamfering corners is not permitted.
 - (f) Reglets between pours of concrete are to be 9.5 mm by 9.5 mm.
 - .2 View these approved areas prior to tendering and during construction employ necessary methods and procedures to achieve surfaces of at least equal quality.

1.6 Concrete Mix Design

- .1 Design of Mix
 - .1 Design the mix in accordance with A23.1 so that concrete will be homogeneous, uniformly workable, readily placeable into corners and angles of forms and around reinforcement by methods of placing and consolidation and finishing employed on the work, but without permitting materials to segregate or excessive free water to collect on the surface. Include consideration of weather, temperature, curing, shrinkage and constructability to meet the construction schedule. The concrete, when hardened, shall have the qualities specified.
 - .2 **HVSCM Concrete:** The mix designs shall be based on laboratory trial mixes followed by full-size batch tests to demonstrate that the materials, mix formula, production techniques and placing techniques chosen will produce concrete meeting the specified requirements. The trial mixes

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shall be used to determine the optimum mix formula, particularly the water-cementitious ratio for the required plastic properties. Mix designs shall take into account the combinations of Supplementary Cementing Materials (SCM's) needed to maintain the construction schedule

- .2 Specified Strength: As called for on drawings. Where walls are integral with columns such as foundation walls, cast walls and columns with concrete of the higher specified strength.
- .3 Modulus of Elasticity (E): For each concrete mix design, the actual Modulus of Elasticity, at all times during construction, is to be not less than $4,500 \cdot \sqrt{f'c}$ (MPa).
- .4 Water Cement Ratio, Cement Content, Slump and Air Content: As called for on the drawings. These requirements are for concrete at the point of placing. For concrete containing Fly Ash the maximum water-cement ratio shall not exceed 0.45.
- .5 Fly Ash: Do not use fly ash in concrete that will be exposed to freeze-thaw cycles or de-icing chemicals.
- .6 Use of calcium chloride is not permitted.

1.7 Samples and Assistance

.1 General

- .1 Supply samples of all materials and the following, the cost of which shall be paid for by this trade.
- .2 **HVSCM Concrete: The contractor shall attend pre-tender, pre-construction and pre-concreting meetings as designated by the Owner. The pre-concreting meeting shall be attended by the placing/finishing crew.**

.2 Concrete Test Cylinders

- .1 Co-operate in the execution of the concrete cylinder testing program. Furnish concrete required, protect specimens against injury and loss, assist in the sampling and storage of specimens.
- .2 For all Portland cement concrete compressive strength tests, 100 x 200 mm or 150 x 300 mm cylinders shall be used.
- .3 Provide sufficient field curing storage facilities so that cylinders representing the various areas can be safely stored in locations representing the curing conditions for those areas. Move the

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field-cured cylinder storage facilities from area to area as the work progresses.

.4 HVSCM Concrete: Pullout tests

.1 Install pullouts to the requirements of the testing and inspection company.

.2 Installations of pullouts shall comply with the requirements of ASTM C900-99 and ACI 228.1-R-95.

.5 HVSCM Concrete: Maturity Tests

.1 Maturity meters shall be used in cold weather to determine when pullout tests can be made.

.2 Installation, equipment and procedures shall comply with ACI 228R-95

.3 Soil Inspection

.1 Assist the geotechnical investigation agency in making their inspections or tests.

1.8 Submittals

.1 Surveys

.1 Submit surveys in accordance with Section 03100, Concrete Formwork and Falsework.

.2 Certificates

.1 Prior to beginning work and when any change in materials or source of supply is proposed, provide the following certificates prepared by an approved inspection company. The cost of this work shall be borne by the Contractor.

.1 Certification that aggregates, cements and cement replacements proposed for the work comply with requirements of specifications and A23.1.

.2 Certification that compressive strength, water-cement ratio, slump, entrained air content and other specified properties will be met, using the proposed mixes.

.3 Give proportions by dry weight of cement, supplementary cementing materials, coarse and fine aggregate, type and amount of admixture or air entraining agents, and

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water-cement ratio, for the mix proposed for each class of concrete. Provide separate mix designs when pump mixes and mixes containing pea gravel are proposed. Describe in detail on the mix design summary the location(s) where each class of concrete is to be placed in the structure.

- .4 State for each mix if and how much fly ash or slag is used in lieu of cement.
- .5 **HVSCM Concrete: With the tender document and when any change in materials or source of supply is proposed, provide the following certificates prepared by an approved inspection company. The cost of this work shall be borne by the Contractor.**

Certification that aggregates, admixtures, cements and Supplementary cementing materials proposed for the work comply with requirements of this specification and A23.1. For fly ash provide details of the source of supply, supplier's quality control programme, test data for at least 3 samples from the previous 3 months supply and details of proposed quality control tests to be made between shipment to the concrete supplier and use in the concrete. Note: A proven source of Type CI fly ash is "Northern Ash" marketed by Lafarge. The intent of this clause is to require a QC programme similar to that applied by LaFarge. Rapid tests that can be made prior to the shipment include: Loss on ignition, carbon analysis, material retained on a 425um sieve, air-jet sieving, air permeability fineness, colour, density, foam-index test and organic material content. The choice of a suitable test or tests will be the responsibility of the fly ash and concrete suppliers.

- .2 Well in advance of construction, submit complete details of placing and compaction procedures for sloping floors, including details of construction and placing of top forms and top form panel.

PART 2 - PRODUCTS

2.1 Materials

- .1 Concrete: Normal density concrete with an air-dry density between 2350 and 2450 kg/m³. Conform to A23.1.
- .2 Cement Type: 10 Normal.

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- .3 Supplementary Cementing Materials: Comply with CSA A3000-98. Fly ash Type CI, slag Type S, silica fume Type SF. SO₃ content of both fly ash and slag to be limited to 5%.
- .4 Nominal Size of Coarse Aggregate: 5 mm to 20 mm. Use pea gravel (5 mm to 10 mm) where concentration of reinforcement requires the use of a smaller diameter aggregate.
- .5 Admixtures: Air entraining agents, water reducing admixtures, or superplasticizers that have been tested and approved for use by The Ministry of Transportation of Ontario.
- .6 Curing Compound: Conform to A23.1.
- .7 Grout Beneath Base Plates: Non-shrink flowable grout In-Pakt or approved equivalent having a compressive strength at 28 days of at least 35 MPa. Where grout is exposed to view or weather, use non-ferrous grout.
- .8 Unshrinkable Fill
 - .1 Cement type-Normal Portland
 - .2 Minimum 24 hour strength - 0.07 MPa
Maximum 28 day strength - 0.4 MPa
 - .3 Class of exposure - N/A
 - .4 Size of coarse aggregate - 20 mm to 40 mm
 - .5 Slump at point of discharge - 150 mm to 200 mm
 - .6 Admixtures shall conform to M.T.C. form 1303 and the latest M.T.C. designated sources list. Calcium chloride or pozzolanic mineral admixtures shall not be used. Air entraining admixtures may be added if desired by the Contractor.

PART 3 - EXECUTION

3.1 Placing Concrete

- .1 Conform to the requirements of A23.1 and the following:
 - .1 Immediately before placing concrete, clean forms and reinforcement of foreign matter.

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- .2 During hot weather conditions, do not use concrete mixed more than 1 hour after introduction of mixing water or 1½ hours during other periods.
- .3 Allow 24 hours minimum to elapse after placing concrete in columns, piers or walls before placing concrete in beams or slabs supported thereon.
- .4 Remove concrete spilled onto forms around hoisting equipment before depositing concrete in these areas.

.2 Pumping Concrete

- .1 Pumping or pneumatic placing of concrete shall only be used if the velocity of discharge is reduced to a point where no separation or scattering of the concrete occurs, and the consistency of the mix has been designed to allow such a system with no adverse effects on the quality of concrete.

3.2 Curing Concrete

.1 General

- .1 Cure all concrete in accordance with A23.1, except as specified herein.

.2 HVSCM Concrete: Cure all concrete in accordance with A23.1, except as specified herein.

.1 Do not use concrete curing compounds.

.2 Cure concrete for a minimum of 7 days at a minimum temperature of 10oC by maintaining concrete surfaces continuously moist. This requirement for moist curing will be strictly enforced.

.3 Cure concrete slab on grade by ponding or absorptive fabric covered with polyethylene and kept continuously moist.

.4 Cure concrete roof slab by absorptive fabric covered with polyethylene and kept continuously moist.

.5 Cure concrete walls and columns as follows:

.1 Continuously soak top.

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- .2 Loosen forms as soon as possible without damaging the concrete.**
- .3 Maintain continuous supply of water to top to keep inside of forms wet**
- .6 Submit details of proposed methods of curing the concrete, including hot weather and cold weather protection, to the Engineer for review.**

3.2 Protection

.1 General

- .1 Conform to the requirements of A23.1 and the following to protect freshly deposited concrete from freezing, abnormally high temperatures or temperature differentials, (see Table 15 CSA A23.1), premature drying, and moisture loss for a period of time necessary to develop the specified properties of the concrete.

.2 Cold Weather Concreting

- .1 Between the 15th of October of any year and the 15th of April of the following year, and whenever the anticipated temperatures conform to CSA A23.1 clause 21.2.3.1, provide on hand and ready for use all equipment necessary for adequate cold weather protection and curing before concrete placement is begun.
- .2 When fresh concrete is to be cast against existing concrete, prevent the loss of heat by extending the protection for the fresh concrete at least 600 mm over the existing.
- .3 Insulate, or enclose within the protective housing, tie rods, reinforcement or metal which projects from the concrete being protected.
- .4 Construct enclosures tight and safe for wind and snow loadings.
- .5 Maintain housing, enclosures and supplementary heat in place for entire period of protection and curing, except that sections may be temporarily removed as required to permit placing additional forms or concrete provided the uncovered concrete is not permitted to freeze. Make up time lost from the required period of protection at the required temperature before protection is discontinued and removed.

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- .6 Locate heating units to avoid heating concrete locally or drying it excessively. Avoid high temperature and dry heating within enclosures.
 - .7 Take particular care to maintain edges and corners of concrete at the required temperature owing to their greater vulnerability to freezing.
 - .8 Provide sufficient insulation, and heat as necessary, to prevent freezing of frost susceptible soil which lies against structural elements; in particular protect soil beneath footings and behind foundation walls until the building is completed.
 - .9 For cold weather protection requirements for placing concrete slabs on grade, see also SLABS ON GRADE clause.
- .3 Hot Weather Concreting
- .1 Follow the provisions of CSA A23.1 clause 21.2.2
 - .2 When rate of moisture evaporation exceeds 1.0 kg/m² per hour, employ the following measures in addition to the requirements of A23.1
 - 1. Use ice as mixing water to lower the concrete temperature.
 - 2. Dispatch ready-mix trucks and organise work to keep mixing time to a minimum. Minimise exposure of mixing trucks to the hot sun while waiting.
 - 3. Provide adequate personnel and organise work to keep placing time to a minimum.
 - 4. Place concrete in layers thin enough and areas small enough so that the time interval for placing is reduced and compaction will ensure complete union of adjacent portions.
 - 5. With formed concrete, reliance shall not be placed on the forms alone to provide curing. Spray formwork with water to keep it tight and free from cracking.
- .4 Protection of Completed Work
- .1 At all times during the work, protect exposed concrete, exposed masonry and other exposed members from staining or becoming coated with concrete leakage due to continuing concreting operations. Members which become coated may be classed as defective by the Consultant.

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- .2 Protect exposed members from staining due to rusting of reinforcement projecting beyond construction joints.
- .3 Take suitable measures to prevent spalling and cracking damage occurring to the structure due to water freezing in expansion joints, small holes, slots, depressions and take suitable measures to prevent damage occurring to foundations and the like due to frost action in the soil or backfill.
- .4 The application of de-icing salts on completed work is not permitted.

3.3 FOOTINGS

- .1 Note the geotechnical report that states that the soil is frost susceptible. During cold weather conditions, carefully protect footing bases from frost since the sandy silt till will weaken quickly on exposure to freezing and thawing temperatures.
- .2 Found footings on naturally consolidated undisturbed soil capable of safely supporting the allowable bearing capacity shown on the drawings within acceptable limits of settlement.
- .3 Founding elevations shown are based upon the geotechnical investigation.
- .4 Founding elevations and allowable bearing capacities must be verified by the geotechnical Consultant before footing concrete is placed.
- .5 If, upon excavating to the elevations shown, the required soil bearing capacities are not achieved, or if they are achieved at a higher elevation, inform the Consultant who will provide instructions as to how to proceed.
- .6 Note actual footing founding elevations on the reproducible as-built drawings.
- .7 Construct footings in a particular area commencing from the lowest footing elevation and proceeding to the higher elevations.
- .8 Proceed in a similar manner for continuous footings.
- .9 Remove water, disturbed soil and foreign matter from footing excavations before placing concrete. Do not permit the soil at founding elevations to soften due to the presence of water in the excavations or construction activity.
- .10 Provide 75 mm skim slab beneath all footings, where identified in the geotechnical report. Skim slab is to be placed after all loose material, foreign matter and water has been removed from the excavation and after

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the geotechnical engineer has inspected the soil at the founding elevation.

- .11 During cold weather, prevent soil adjacent to and beneath all footings from freezing. Do not pour footings on frozen soil or soil which has been allowed to freeze and thaw. If the soil at founding elevations is frozen or was frozen and thawed, remove affected material and found footings on unaffected soil with the required characteristics at no extra cost to the Owner.
- .12 Where excavations for mechanical or electrical services, pits, adjacent foundations and the like encroach upon a 1 in 2 slope between corners of footings and bottom corners of excavations, lower footings a suitable amount so as not to exceed the 1 in 2 slope at no extra cost to the Owner.

3.4 Construction Joints

- .1 Obtain approval from the Consultant for location and details of construction joints not shown.
- .2 The maximum length of a concrete slab pour shall be 40 m.
- .3 The maximum length of a concrete foundation wall pour shall be 15 m.
- .4 The maximum height of a concrete pour shall be 5 m.

3.5 Waterstops

- .1 Maintain waterstops in position during placing of concrete. Support the waterstops during the progress of the work to ensure the proper embedment in the concrete. Equally divide the symmetrical halves of the waterstops between the concrete pours at the joints. The centre axis of the waterstops shall coincide with the joint openings at the plane of installation of the waterstop. Ensure maximum density and imperviousness of the concrete by thoroughly working it in the vicinity of all joints.
- .2 Place concrete around waterstops by careful working, routing, and vibrating to ensure that all air pockets have been eliminated.

3.6 Separation Strips

- .1 Where shown on the drawings place concrete in the separation strips after concrete in adjacent areas has cured for the duration noted on the drawings.

3.7 Slabs On Grade

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.1 General

- .1 Do not place concrete slabs on grade until the specified sub-floor material has been placed, inspected and approved.
- .2 Do not place concrete on a frozen sub-grade, or on one that contains frozen materials.
- .3 Do not place concrete on a sub-grade that has been frozen and thawed until the sub-grade has been reviewed by the Consultant and approved. If, in the Consultant's opinion, the safe bearing capacity of the sub-grade has been reduced to below 25 kPa, remove the affected materials and replace with compacted granular fill at no additional cost to the Owner.
- .4 Place clear crushed stone over the sub-base, to depths shown or specified. Thoroughly roll and consolidate to the lines and levels required.
- .5 Place a bond breaker, minimum 10mm asphalt impregnated fibre board (A.I.F.B.) between edges of slab on grade and abutting surfaces. Where slab on grade is exposed to de-icing chemicals, provide an approved sealant at the joint between the slab on grade and abutting surfaces.
- .6 Upon approval of the placement of the sub-floor material and setting of reinforcement, place and consolidate concrete and finish and cure as specified herein.

3.8 Architectural Concrete

- .1 The following exposed concrete surfaces above ground floor are architectural concrete: all columns full height, walls as indicated on architectural drawings, all slab soffits and at the top of exterior faces of foundation and retaining walls.
- .2 For architecturally exposed concrete, a consistent appearance is essential. Aggregate size, aggregate batch, cement batch, temperature range at time of placing and curing, method of concrete placement, vibration and length of time in forms are all factors that affect the final appearance. These factors are to be consistent throughout the project for all architecturally exposed concrete.
- .3 For architecturally exposed concrete, the method of concrete placement shall be either by bucket or pump, but not both. Use only one method for all pours.
- .4 Sample Panels/Areas

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- .1 Well in advance of constructing architectural concrete, to prove out the materials and procedures proposed, construct a sample section of each type of architectural concrete utilising portions of the concrete structure not exposed to view in the finished building. The samples are to include as a minimum 2 circular columns, a 5 m length of concrete wall and a 5 m x 5 m area of exposed concrete floor finish.
- .2 If the sample panels do not meet the minimum standards specified it may be necessary to construct additional samples, again utilising portions of the structure to be concealed. The quality of the approved samples along with the criteria specified shall be the minimum standards for architectural concrete.
- .5 Placing of Concrete
 - .1 Before concrete is placed, thoroughly clean forms, re-tighten as is necessary and saturate the surface of construction joints and form sides with water.
 - .2 In walls or columns, except where these are to be sandblasted, begin the pour by depositing in the bottom of the form a 75 mm layer of cement sand mortar of the same mix as the concrete used for the work, except that the coarse aggregate is omitted. Pour concrete immediately after the grout is poured.
 - .3 The maximum free drop of concrete shall not exceed 1.3 m.
 - .4 Deposit concrete in as close to its final position as possible and do not allow to flow laterally more than 0.6 m.
 - .5 For depositing concrete in walls provide suitably sized tapered pouring boxes to funnel the concrete into the forms. Provide sufficient boxes for each pour such that they can be placed simultaneously at approximately 2 m on centres for the entire length of the pour.
 - .6 To compact concrete use internal vibrators maximum 25 mm in diameter as required. Apply vibrators at sufficiently short intervals, (about 0.5 m to 1.0 m) that vibrated areas overlap without omission of any part. Ensure that the vibrators are inserted through the layer being compacted but take care not to damage form sheathing. Leave vibrator in place from 5 to 15 seconds and withdraw slowly leaving the vibrator operating.
 - .7 Arrange operations so that once a pour is started, concreting is carried on continuously and the concrete at the surface of the pour is maintained plastic until the completion of section.

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- .8 Shortly after concrete is placed and compacted to the top of walls or columns or to the top of construction joints, rework the concrete with wooden chisels at the exposed faces to a depth of at least 0.6m and then re-vibrate.
 - .9 At the correct time provide a fine wood float surface to tops of walls, balustrades, retaining walls and the like. Remove laitance as necessary before finishing the concrete. After stripping, lightly rub corners with an emery stone to eliminate sharp edges.
 - .10 Trowel the surface of construction joints adjacent to exposed faces, flush and level. Joints in walls shall be made at the top of any reglet unless shown otherwise.
- .6 Protection
- .1 At all times during the work protect architectural members as required with polyethylene sheets or the like from staining or becoming coated with leakage, due to continuing concreting operations. Protect concrete from staining due to rusting of reinforcing steel.
 - .2 At all times during the work protect surfaces, corners and edges of architectural members from scratching and chipping by suitable means.
- .7 Treatment of Formed Surfaces
- .1 After forms are stripped go over the surface carefully, removing loose concrete, lumber in reglets, minor fins and the like, leaving the surface clean. After the surfaces are cleaned the Consultant will make an examination of them to determine their acceptability. If unacceptable, the Contractor shall remove the members and replace them at no extra cost to the Owner.
 - .2 As previously noted, patching will only be permitted where it is required to an insignificant extent. If the Consultant permits patching, demonstrate to the Consultant's satisfaction that the patch will accurately match the colour and texture of the surrounding concrete and will have satisfactory tenacity.
- .8 Smooth Rubbed Finish, Walls and Columns
- .1 Produce finish on concrete no later than one day after forms are removed. Wet surface and rub with carborundum brick until uniform colour and texture are produced. Do not use cement paste.
- .9 Filling Form Tie Holes

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- .1 On exterior surfaces exposed to view, seal the form tie holes with Mills Grout Plugs in accordance with manufacturer's instructions.
- .2 Fill the 40 mm depth of the form tie hole with a grout containing an approved bonding agent which matches the parent concrete, except that the coarse aggregate shall be omitted and the proper amount of white cement and/or limestone screenings shall be used to adjust the colour of grout to match the parent concrete when cured.
- .3 When consistency of the grout shall be such as to be slightly damp to the touch (just short of "balling"), hammer the grout back from the surface of the surrounding concrete approximately 10 mm. Leave the surface of the grout plug smooth and ensure that any excess grout is removed from the surface of surrounding concrete.
- .4 On interior surfaces exposed to view, where ties are to be exposed or accentuated, fill form tie holes with natural colour plastic, set-back plugs such as RSP manufactured by Richmond Screw Anchor Company, Toronto or approved equal in accordance with the manufacturer's instructions.

.10 Cleaning Surfaces

- .1 As late as possible prior to turning the building over to the Owner, clean down concrete to remove surface discolourations, efflorescence and the like. Use a suitable cleaning agent, which will not itself stain the surfaces or mar the texture through chemical reaction.

3.9 Treatment of Formed Surfaces not Designated as Architectural Concrete

- .1 Do work in accordance with A23.1 and as follows:
 - .2 Provide smooth form finish to concrete surfaces exposed to public view and surfaces to receive plaster, damp-proofing, moisture resistant membrane and the like.
 - .1 Remove traces of form lining compound from concrete surfaces, which may affect the bonding of following surface application.

3.10 Openings Through Completed Members

- .1 Do not cut openings through completed members without the Consultant's approval.
- .2 Where the location of openings is approved, locate the reinforcement by x-ray, cover meter or other positive means as required by the Consultant and adjust the location of the opening so that no reinforcement is cut unless specifically approved otherwise in writing by the Consultant.

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3.11 Making Good

- .1 Make good temporary openings left in concrete construction around pipes, ducts and the like using a mortar of the same proportions as the surrounding work. Reinforce mortar with welded wire fabric where openings exceed 75 mm. Roughen existing surfaces to receive mortar or apply suitable bonding agent such that mortar will be securely bonded to existing concrete.

3.12 Grouting Beneath Base Plates

- .1 Grout beneath plates bearing on concrete with an approved non-shrink flowable grout. Conform with the manufacturer's directions for mixing and placing grout. Completely fill voids below plates. Fill voids left by shims after shims are removed.
- .2 During cold weather, preheat base plates and footings and maintain temperature at minimum 12 degrees C. for 6 days after grouting.
- .3 Refer to Section 05120 for lifting of baseplates to determine adequacy of grouting. If defects are found, more base plates will be raised.

3.13 Unshrinkable Fill

- .1 Unshrinkable fill is intended for use locally in place of granular backfill below slabs on grade or within excavations where compaction of granular material is difficult to achieve. It is not intended for use below footings or around foundation walls, tunnels, laterally loaded caissons, etc., where vertical and/or lateral structural bearing capacities are required. Obtain written approval from the Consultant prior to using unshrinkable fill.
- .2 The unshrinkable fill material shall be placed at a slump of between 150 and 200 mm. The material shall flow into the excavation so that it fills the entire space. Care shall be taken to ensure that no air is entrapped beneath horizontal projections or in other locations within the excavation.
- .3 Where bracing, shoring and/or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, this support system shall be removed as backfilling proceeds.
- .4 If the excavation is within the travelled portion of the roadway, it shall be covered for at least 24 hours with steel plate of sufficient strength to support traffic during this period. Where road traffic is not to be accommodated, the backfilled excavation shall be covered with wooden planking or other protection for users of the road allowance until the unshrinkable fill will support the weight of an adult person.

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3.14 Concrete Work At Existing Structure

- .1 Before proceeding with any work in or adjacent to the existing structure, verify that conditions are as indicated on the drawings. If they are not, advise Consultant of discrepancies and do not proceed until the Consultant has given instructions.
- .2 Install footings adjacent to these existing footings in the sequences indicated, and against undisturbed soil as shown, and so that the stability of the existing footings and existing slabs on grade are maintained at all times. Temporarily support existing foundations as required.
- .3 Where openings are shown to be cut into the existing structure, drill at corners and saw cut remainder such that saw cuts do not extend into structure to be retained. Overcutting may require major structural strengthening.

3.15 Sloping Slabs

- .1 In the case of sloping slabs, employ suitable concrete placing and compaction procedures to ensure that completed concrete has the specified design characteristics. In particular, prevent movement of plastic concrete resulting in cracking, loss of bond, etc., and to achieve a surface equivalent to a fine wood float finish suitable to receive a membrane.
- .2 Upon approval of the placement of the sub-floor material, place and consolidate a uniform thickness of slab on grade concrete top within 40 mm of top. Note 50 mm maximum slump. Co-ordinate with Section 03200 the immediate placement of reinforcement on top of the first layer of concrete. Place, consolidate, finish and cure the final 40 mm thickness of slab to the tolerances specified.

3.16 Quality Control

- .1 Implement a system of quality control to ensure that the minimum standards specified herein are attained.
- .2 Bring to the attention of the Consultant any defects in the work or departures from the Contract Documents, which may occur during Construction. The Consultant will decide upon corrective action and give his recommendations in writing.
- .3 The Consultant's general review during construction and inspection and testing by independent inspection and testing agencies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

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3.17 Notification

- .1 Prior to commencing significant segments of the work, give the Consultant and independent inspection and testing agencies appropriate notification so as to afford them reasonable opportunity to review the work. Failure to meet this requirement may be cause for the Consultant to classify the work as defective.

3.18 Inspection and Testing

- .1 Appointment of Independent Inspection and Testing Companies
 - .1 The Owner will appoint the Independent Inspection and Testing Companies to make inspections or perform tests as the Consultant directs. The Independent Inspection and Testing Companies shall be responsible only to the Consultant, and shall make only such inspections or tests as the Consultant may direct.
 - .2 When defects are revealed, the Owner may request, at the Contractor's expense, additional inspection or testing to ascertain the full extent of the defect.
- .2 Tests on Concrete Materials
 - .1 Concrete Strength: Cylinder testing will be carried out in accordance with A23.1 and as follows: Three companion laboratory cured concrete standard compression test cylinders; two tested at 28 days and one tested at 7 days, constitute a strength test. During the placing of concrete in cold weather one additional field cured test cylinder will be made and tested at 7 days. The results of the 7 day tests related to curing procedure shall be the basis to strip soffit forms from horizontal or inclined members.
 - .2 **HVSCM Concrete: Pullout tests: Pullout testing will be carried out in accordance with ASTM C900 and ACI 228.1R-95. Contractor to install inserts to the requirements of the Inspection and Testing Company.**
 - .3 **HVSCM Concrete: Maturity tests will be carried out in accordance with ACI 228R-95**
 - .4 Grout Under Baseplates: At least one strength test may be made each day that grout is placed under baseplates.
- .3 Inspection of Soil.
 - .1 Soil at footing founding elevations will be inspected.

3.19 Defective Materials and Work

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- .1 Where evidence exists that defective work has occurred or that work has been carried out incorporating defective materials, the Consultant may have tests, concrete coring, inspections or surveys performed, analytical calculations of structural strength made and the like in order to help determine whether the work must be repaired or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense, regardless of their results, which may be such that, in the Consultant's opinion, the work may be acceptable.
- .2 All testing shall be conducted in accordance with the requirements of the Ontario Building Code, except where this would in the Consultant's opinion cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or work which fail to meet specified requirements may be rejected by the Consultant whenever found at any time prior to final acceptance of the work regardless of previous inspection. If rejected, defective materials or work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION 03300