

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

- A. Comply with Division 1, General Requirements.
- B. Comply with requirements of CSA A23.1 and A23.2, except where noted otherwise in this Specification.
- C. The following sections form part of this Section:
 - 1. Section 03 60 00, Grouting.
- D. Do not use materials that are toxic in installed condition. Do not use volatile organic compounds where not permitted by law. Where use of volatile organic compounds is permitted, provide adequate ventilation and take necessary safety precautions.
- E. Section Includes:
 - 1. Normal-density concrete.

1.2 DEFINITIONS

- A. Exposed Concrete: Visible concrete surfaces inside or outside of structures, including surfaces above liquid level.
- B. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 5 mm, cracks 0.1 mm or wider as well as any crack that leaks in hydraulic structures and below grade habitable spaces; cracks 0.25 mm and wider in non hydraulic structures, spalls, chips, air bubbles greater than 10 mm in diameter, pinholes, bug holes greater than 4mm in diameter, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints or penetrations or openings, fins and other projections, form pop outs, texture irregularities, and stains and other color variations that cannot be removed by cleaning.
- C. New Concrete: Less than 60 days old.
- D. Type of concrete: Project specific concrete type and shall not be confused with type of cements or finishes.
- E. Exposure classes of concrete: As defined in Table 1 CSA A23.1.
- F. Water/Cementing Material Ratio (W/C): A weight ratio of total water content including admixtures over the weight of all cementing materials.

1.3 REFERENCES

- A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
1. Canadian Standards Association (CSA):
 - a. A23.1, Concrete Materials and Methods of Concrete Construction.
 - b. A23.2, Methods of Test and Standard Practices for Concrete.
 - c. A23.3, Design of Concrete Structures for Buildings.
 - d. G30.18-M, Billet-Steel Bars for Concrete Reinforcement.
 - e. A3001, Cementitious Materials for Use in Concrete.
 - f. A3002, Masonry and Mortar Cement.
 - g. A3003, Chemical Test Methods for Cementitious Materials for Use in Concrete and Masonry.
 - h. A3004, Physical Test Methods for Cementitious Materials for Use in Concrete and Masonry.
 - i. A3005, Test Equipment and Materials for Cementitious Materials for Use in Concrete and Masonry.
 - j. S269.1, Falsework for Construction Purposes.
 - k. S269.3-M, Concrete Formwork.
 2. American Concrete Institute (ACI):
 - a. 304.2R, Placing Concrete by Pumping Methods.
 - b. 347, Guide to Formwork for Concrete.
 3. American Society for Testing and Materials International (ASTM):
 - a. C260, Specifications for Air-Entraining Admixtures for Concrete.
 - b. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - c. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - d. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 4. AASHTO T 318-02 Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
 5. Reinforcing Steel Institute of Canada (RSIC):
 - a. Reinforcement Steel Manual of Standard Practice.
 6. International Conference of Building Officials (ICBO):
 - a. ICBO Research Report.
 7. National Lumber Grades Authority (NLGA):
 - a. Standard Grading Rules for Canadian Lumber.

1.4 PERFORMANCE REQUIREMENTS

- A. Concrete for the project is used in water and waste water facilities. Ph for the liquids is normally neutral at about 7. Various chemicals are added to help the process. Degradation of organic material emits gases like hydrogen sulphide which when combined with moisture forms mild sulphuric acid. Life expectancy of water and waste water plant is 60 to 80 years.

- B. This project structures are used for potable water. Potable water requirements are in force.
- C. Type of Concrete Class of Exposure and Compressive Strengths.
 - 1. Normal-density concrete:
 - a. Class of Exposure: C-2 -32 MPa at 28 days w/c 0.45.
- D. Performance requirement for temperatures during curing.
 - 1. Design concrete mix taking in the account the expected ambient temperature during the curing. Peak curing temperature of concrete shall not exceed 40 degree C and shall not be less then 10 degrees C.
- E. Density.
 - 1. Air entrained normal density concrete: As defined in CSA 23.1-09 Clause 3 except the density shall be not less than 2250 kg/m³.
- F. Construction Tolerances:
 - 1. Comply with CSA A23.1-09 Clause 6.4 unless noted otherwise.
- G. Concrete Finishes:
 - 1. As specified in Clause 3.3.

1.5 SUBMITTALS

- A. Concrete Mix Design:
 - 1. Design in accordance with CSA 23.1 Table 5 based on performance requirements.
 - 2. Submit proposed mix, and supplier's applicable standard deviations.
 - 3. Tabulate concrete mixes. Indicate type of cements, size of coarse aggregate; water/cementing material ratio, admixtures used, air content, slump, and locations of use for each mix. Identify mix with pump or bucket type of discharge.
 - 4. Concrete mix designs will be reviewed for conformance with requirements of the Specifications and will be returned with the Contract Administrator's comments.
- B. Source Quality Control Submittals:
 - 1. Provide certification that source for fine and coarse aggregates are not subject to deleterious expansion.
 - 2. Chemical admixtures, used in the production of concrete for potable water structures, shall be certified as safe product from recognized approving authorities such as NSF 61.
- C. Quality Control Submittals:
 - 1. Submit Concrete quality control plan for the project. Include the following:
 - a. Certification from a professional engineer who has designed the mix based on the requirements of the Contract Documents and that concrete mix will meet the performance requirements. Where the mix designer is not a professional engineer, then the signing officer of the ready mix plant shall sign the certification.

- b. Identify the Company and contact names of subcontractors, material suppliers, and testing companies involved with concrete manufacture and placement.
 - c. Identify concrete requirements for each element of the project.
 - d. Identify all tests that will be used for material acceptance and indicate minimum specification requirements for each test.
 - e. Identify the frequency of testing for each test.
 - f. Identify the course of action to be taken if the testing program indicates that specification requirements have not been met.
 - g. Concrete quality control plan shall not take precedence over any other Contract documents.
2. Submit concrete delivery records.
 3. Submit certified mill test reports of steel reinforcing bars: Determine physical and chemical properties of steel reinforcing in accordance with requirements of CAN/CSA-G30.18-M.
- D. Concrete Placing Schedule:
1. Submit concrete placing schedule.
- E. Certificates:
1. Submit certificate of Ready Mixed Concrete Production Facilities.
 2. Submit certification that aggregates will not, nor have the potential to, react with cement to result in deleterious expansion in the concrete.
 3. Submit certification that deleterious substances in aggregate are within limits specified in CSA A23.1-09, Table 12 - Limits for Deleterious Substances and Physical Properties of Aggregates.
 4. Submit certification that proposed performance mix will produce concrete meeting the requirements of Specifications.
 5. Submit certification that proposed mix design strengths have been selected allowing for the supplier's standard deviations as indicated in CSA A23.1-09, Clause 4.4.6.6- Compressive Strength Requirements.
 6. Submit certification that proportion of supplementary cementing material in combination of General Use (GU) hydraulic cement will provide the performance of the specified cement type.
Submit certification that bonding agent, if used, will meet the requirements of Specifications.
- F. Reinforcing Bars:
1. Submit reinforcing bar placement drawings prepared in accordance with Reinforcement Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada and as specified below.
 2. Indicate reinforcing bars that form part of an individual concrete placement and reinforcing bars that extends into adjacent placements.
 3. For each reinforcing bar placement shop drawing, submit a separate bar list and bending schedule showing size, shape, dimensions, and numbers of bars required for each bar type.

4. Identify reinforcing bars in the bar list and bending schedule with a separate bar mark that corresponds to bar marks shown on reinforcing bar placement drawings.
5. If bar list and bending schedule contain details of bars of more than one reinforcing bar placement drawing, then arrange bar marks in separate groups for each placement drawing. Clearly indicate for each bar mark the corresponding reinforcing bar placement drawing number.
6. Do not add new information on previously reviewed shop drawings.
7. Reinforcing bar placement shop drawings will be reviewed for bar sizes, locations, and spacing, and will receive submittal stamp and signed. Reviewed bar list and bending schedule will be dated only.

1.6 QUALITY ASSURANCE

- A. Ready Mixed Concrete Producer: Certified member in good standing of the local Ready Mixed Concrete Association.
- B. Concrete Testing:
 1. Testing of concrete for materials, compression and water content of freshly mixed concrete will be done by agencies paid for by the City.
 2. Pay for additional testing required because of changes in material or the mix proportions, as well as any extra testing of concrete or materials occasioned by their failure to meet the specification requirements.
 3. The use of testing services does not relieve the Contractor of his responsibility to provide materials and construction in compliance with the Drawings and Specifications.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturers' recommendations for delivery, storage, and handling.
- B. Store materials in a manner that will prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from site.
- C. Ship bundles of reinforcing bars identified by tags containing bar marks along with bar list.
- D. Store materials to prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from site.

1.8 SITE CONDITIONS

- A. Influence of Ambient Concrete Temperature on Concrete Crack Control:
 1. To minimize the formation of thermal cracks during placement and curing, maintain previously cured concrete and concrete that will be placed against it at the same temperature.
 2. Failure to minimize temperature differential between adjacent pours will result in temperature induced cracking. Repair such cracks as specified in this Section.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Portland Cements/ Blended Hydraulic Cements:
 - 1. CSA A23.1 Table 7 Types of blended hydraulic cement:
Type: GU as appropriate.
 - 2. Supplementary Cementing materials shall be limited to ground granulated blast-furnace slag (S), fly ash (F) and silica fume (SF).

- B. Aggregates:
 - 1. Normal-density Concrete:
 - a. Coarse aggregate: CSA A23.1; rough and angular gravel or crushed stone.
 - b. Fine aggregate: CSA A23.1; natural sand.

- C. Admixtures:
 - 1. Admixtures used for potable water hydraulic structures shall be NSF 61 certified. Import where admixtures are not locally produced.
 - 2. Compatible with each other and with other concrete materials.
 - 3. Calcium chloride, thio-cyanates, or admixtures containing more than 0.05% chloride ions are not permitted.
 - 4. Air-entraining admixture: ASTM C260; non-detergent type.
 - 5. Water-reducing admixtures: ASTM C494; Type A.
 - 6. Set-retarding admixture: ASTM C494; Type B.

- D. Water: CSA A23.1; clear and free from oil, acid, alkali, organic matter, or other deleterious substances with a maximum soluble chloride ion content of 0.10 percent by weight.

- E. Bonding Agent: Suitable for conditions of service and performance requirements of this Section.

- F. Polyurethane injection resin for sealing cracks, single-component Diphenylmethane Diisocyanate (MDI) based, water-activated, hydrophobic type resin:
 - 1. Flexible Resin by Multiurethanes Limited.
 - 2. Hydro Active Flex LV by DeNeef Construction Chemicals (U.S.) Inc.

- G. Reinforcing Bars:
 - 1. Deformed steel bars: CAN/CSA-G30.18-M; Grade 400R except Grade 400 W where welding is indicated or specified. Do not substitute with epoxy-coated bars.
 - 2. Comply with CSA A23.1 and CSA A23.3.
 - 3. Tolerances:
 - a. Length: Plus or minus 25 mm.
 - b. Height of truss bar: Plus 0 to minus 10 mm.
 - c. Outside dimensions of stirrups, ties, and spirals: Plus or minus 10 mm.

- d. Other bends: Plus or minus 25 mm.
4. Use longest bar possible.
5. Keep number of splices to a minimum.
6. Do not weld chairs, bolsters, bar supports, or spacers to reinforcing bars.

2.2 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 1.6 mm diameter wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Adequate for accurate placing and as required for construction loads.
2. Provide non-conductive bar supports in contact with exposed surfaces that has geometry and bond characteristics that prevents moisture movement from the surface to the reinforcement.

2.3 CONCRETE MIXES

A. General:

1. Establish proportions of cementing materials, aggregates, water, and admixtures required to produce consistent workable concrete that when placed properly is watertight and durable with strength and other properties specified. Comply with - CSA A23.1-09 Clause 4.3.6 Volume Stability Considerations.
2. Use same type and brand of cement/cementing material throughout.
3. Comply with and allow for the supplier's Standard Deviation as specified in CSA A23.1-09 Clause 4.4.6.6- Compressive Strength Requirements. If the concrete supplier has no established Standard Deviations for concrete of the specified strengths, use a value of 4 MPa minimum.

B. Types of Normal-density Concrete:

1. Exposure Class C-2: Concrete for equipment bases.

C. Mixes for Normal-density Concrete:

1. Cementing Materials Content:
 - a. Provide cementing materials contents as required to meet performance.
2. Coarse Aggregates:
 - a. Nominal size 40 mm to 5 mm, unless noted otherwise.
3. Air Content:
 - a. Comply with CSA A23.1-09, Table 4 - Requirements for the Air Content Categories.
 - b. Provide air content category 2, unless noted otherwise.
4. Admixtures:
 - a. Use water-reducing admixture as necessary.

2.4 SOURCE QUALITY CONTROL

- A. Testing by an independent laboratory in accordance with CSA A23.1 and A23.2, where test results less than one year are not available, to determine:
 - 1. Chemical composition and physical properties of aggregates.
 - 2. Presence and quantity of deleterious substances in aggregates.

2.5 FORM MATERIALS

- A. General:
 - 1. Materials:
 - a. Lumber for Formwork and Falsework: Grade-marked sawn lumber graded in accordance with NLGA.
 - b. Plywood for Formwork: CSA A23.1; high density overlay (plastic overlay) grade plywood. Plywood may be of lower finish grade when use in conjunction with form liner.
 - c. Fibreglass or steel forms in undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
- B. Form Release Agent:
 - 1. Use form release agent on all cast in place concrete.
 - 2. Material: Release agent that does not bond with, leave residue on, stain, or adversely affect concrete surfaces, and does not impair subsequent treatments of concrete surfaces when applied to forms
 - 3. Freezing point: Minus 15 degrees C or lower.
 - 4. Manufacturers and Products:
 - a. Master Builders, Inc.; Rheofinish.
 - b. Cresset Chemical Company; Crete-Lease 20-VOC.
 - c. NCA/Acrow-Richmond Ltd.; RICH-COTE.
 - d. W.R. Meadows of Canada Ltd.; Sealtight Duogard.
 - e. Euclid Admixture Canada, Inc.; Eucoslip VOX.
- C. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides preventing loss of paste or water between the two surfaces.

PART 3 EXECUTION

3.1 PREPARATION

- A. General:
 - 1. Determine requirements of other trades, inform concerned trades, and assume responsibility for location, installation, and quality of items which affect the Work of this Section.
- B. Preparation of Surfaces:

1. Remove water and debris from surfaces on or against which new concrete will be placed.
2. Roughen and clean surfaces of previously placed concrete against which subsequent concrete will be placed.
3. Clean reinforcing bars of loose rust, mill scale, dried cement paste, mud, oil, or other coatings that will affect adhesion in accordance with CSA A23.1-04, Clause 6.1.5 Surface Conditions of Reinforcement, prior to placing concrete

3.2 PLACING CONCRETE

A. General:

1. Do not commence concrete placing until sufficient manpower and equipment is available to complete the placement expeditiously preventing the formation of cold joints, and to produce specified surface finish.
2. Provide standby equipment for critical items in case of equipment failure.
3. Verify that cast-in-place accessories, inserts, and reinforcement are set correctly and are not disturbed during concrete placement.
4. Place concrete on dry and clean substrate.

B. Depositing:

1. Deposit concrete in a manner that prevents segregation in accordance with CSA A23.1-09 Clause 7.2.4 - Depositing.

C. Time Limitations on Concrete Placement:

1. Do not use concrete after a period of two hours has passed since first mixing of ingredients.

D. Adverse Weather Conditions:

1. Make suitable arrangements to prevent damage to fresh concrete, under adverse weather conditions.
2. Do not place concrete when ambient temperature is below 5 degrees C or approaching 5 degrees C and falling, without special protection.
3. Provide heated enclosures when air temperatures are below 5 degrees C.
4. Maintain surface temperature of concrete above 5 degrees C.

E. Consolidation:

1. Consolidate the concrete during and immediately after depositing, thoroughly and uniformly by means of tamping, hand tools, finishing machines, and vibrators in order to obtain dense, watertight, homogeneous concrete well bonded to reinforcing bars.
2. Do not allow concrete to form cold joints.

3.3 CURING & FINISHING

- #### A. Wet Cure for 7 days.

- B. During curing, ensure the temperature is kept uniform over the whole surface and across the cross section of the concrete. A temperature gradient across the member may cause cracking.
- C. Provide Steel Trowel Finish (Type S-1):
 - 1. Trowel surface with steel hand or power trowel in accordance with CSA A23.1-09, Clause 7.5.4.3. Trowelling, keeping blade flat at first and raising blade angle a little more on subsequent passes. Leave surface smooth, dense, of fine uniform texture without a swirl and free of blemishes.
 - 2. Do not use dry cement or additional water during trowelling. Do not over finish.
 - 3. Do not use power machine when concrete has not attained necessary set to allow finishing. Do not introduce high and low spots in slab during trowelling.

3.4 REPAIR OF TEMPERATURE AND SHRINKAGE INDUCED CRACKS

- A. Repair cracks in the completed structures employing a suitable polyurethane injection technique to make such cracks completely watertight after repair.
- B. Remove surface injection materials following completion of work and finish affected areas to match surrounding concrete.
- C. For dry areas, propose repairs to meet the specifications.

3.5 CONCRETE BONDING

- A. To Existing Concrete:
 - 1. Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 6 mm.
 - 2. Saturate surface with water for 24 hours prior to placing new concrete.

3.6 FIELD QUALITY CONTROL

- A. General:
 - 1. Tests will be made throughout progress of the Work and will be paid for by the the City to determine concrete quality. Tests will be in accordance with CSA A23.1 and A23.2. Provide labour, concrete, and other facilities for making the test specimens.
 - 2. Provide and maintain facilities for storing and initial curing of test cylinders, and provide suitable crates for shipping test cylinders in accordance with CSA A23.2-09 Test Method A23.2-3C - Making and Curing Concrete Compression and Flexural Test Specimens. Provide microwave oven and facility of carrying out test in field.
 - 3. The testing laboratory shall provide the test results to the the City, Contract Administrator, Contractor and material supplier within 5 days of availability. For a test that fails to meet the Specification inform the Contract Administrator, Contractor and material supplier within 48 hours of the test.

4. Testing company in coordination with the Contractor shall consider using on line secured website such as CMATS to record, view and distribute concrete test data. Data shall be entered in standard format as designed by the software. Protocol for distribution and filing of test results shall be agreed upon at the pre placement meeting.
- B. Standard Strength Tests:
1. Provide concrete for one standard strength test consisting of 3 cylinders for each 40 m³ of concrete of each type placed in any day. If the amount placed, for each type of concrete is less than 40 m³ in a day, provide concrete for one standard strength test of 3 cylinders. One cylinder will be tested at 7 days and one at 28 days and one cylinder at 56 days.
- C. Air Content Tests:
1. Testing agency will carry out air content tests in accordance with CSA A23.1 and A23.2.
- D. Slump Tests:
1. Testing agency will carry out slump tests in accordance with CSA A23.1 and A23.2.
- E. Failure to Meet Strength, Air Content, or Slump Requirements:
1. When measured slump or air content falls outside of required limits, carry out a check test immediately on another portion of the same sample. In the event of a second failure, the concrete will be considered to have failed to meet the requirements. Remove the whole batch, from which the samples were taken, off the site.
 2. When the strength requirement provisions are not met, carry out one or more of the alternatives:
 - a. Change the mix proportions.
 - b. Carry out nondestructive testing.
 - c. Provide additional curing on portions of the structure represented by the test specimen.
 - d. Core drill portion of the structure in question and test cored cylinder in accordance with CSA 23.2-09 Test method A23.3-14C Obtaining and testing drilled cores for compressive strength.
 - e. Load test structure to design loading.
 - f. Other test the City may require for acceptance.
 3. When, after carrying out these requirements, there is still doubt about of the adequacy of the concrete, strengthen or replace, as directed, portions of the Work which failed to develop the required strength.
- F. Uniformity of Mixed Concrete
1. If the results of slump, slump flow, air content or density for any mix design do not comply with CSA A23.1-09, Table 13 - Determination of Within-Batch

Uniformity, alter mixing operations and equipment until tests indicate that the requirements are satisfied.

- G. Concrete Delivery Records:
1. Submit with each batch of concrete before unloading, a typed delivery ticket prepared at the ready mix plant containing following information:
 - a. Name of ready-mix batch plant.
 - b. Date and serial number of ticket, truck plate number.
 - c. Name of Contractor.
 - d. Project Name.
 - e. Specific class of concrete with identifying mix number.
 - f. Amount of concrete in cubic metres.
 - g. Time loaded or of first mixing of cement and aggregates.
 - h. Amount of admixtures, or water added on site.
 2. Keep records of the time when each load arrives at the site and when discharge is completed. Record the temperature of fresh concrete.

3.7 FORM SURFACE PREPARATION

- A. Remove water, laitance, curing compound, and other debris and thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.
- B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.
- C. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.8 ERECTION

- A. General:
 1. Unless specified otherwise, follow applicable recommendations of CSA S269.1, and S269.3-M.
 2. Align form joints and make watertight. Keep number of joints to a minimum.
 3. Laterally brace formwork and falsework and prevent displacement during concrete placement.
 4. Form chases, openings, projections, recesses.
 5. Form around pipes, mechanical, and electrical equipment which penetrate the concrete structure.
 6. Incorporate frames, castings, pipes, sleeves, and similar items into formwork if required.
 7. Do not re-use damaged formwork which may not provide a uniform consistent finish.
- B. Beveled Edges (Chamfer):
 1. Form 20 mm bevels at concrete edges, unless otherwise shown.

2. Where beveled edges on existing adjacent structures are other than 20 mm, obtain the Contract Administrator's approval of size prior to placement of beveled edge.

C. Form Tolerances: Comply to tolerances of CSA A23.1.

D. Fasteners: Use only galvanized nails and fasteners when such fasteners will be left in place in the permanent structure.

3.9 FORM REMOVAL

A. Remove nails, fasteners, tie wire and similar items at the surface.

3.10 REINFORCING BAR INSTALLATION

A. Notify the Contract Administrator when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Place reinforcement within tolerances specified in CSA A23.1 Clause 6.6.8 Tolerances for location of reinforcement.

C. Tying Reinforcing Bars:

1. Bend tie wire away from concrete surface. Ensure a cover for tie wires, form tie bolts etc are same as the reinforcing bars. Do not let reinforcing tie wire touch formwork or be exposed in the finished concrete structure.

D. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.

E. Unless permitted by the Contract Administrator, do not cut reinforcing bars in field.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Grouting including:
 - a. Filling openings and blockouts.
 - b. Grouting under base plates for equipment and fittings, and structural steel.
 - c. Grouted-in dowels for connecting to existing concrete.
 - 2. Alterations and modifications to existing structures, including:
 - a. Removing existing concrete.
 - b. Cutting construction joint keys in existing structures.
 - c. Finishing of existing concrete.
 - d. Refinishing.

1.2 REFERENCES

- A. Comply with the latest edition of the following codes and standards and all amendments thereto.
 - 1. American Concrete Institute (ACI):
 - a. 351.1R, Grouting between Foundations and Bases for Support of Equipment and Machinery.
 - 2. American Society for Testing and Materials International (ASTM):
 - a. C230/C230M, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - b. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - c. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product data of grouts including installation, application, and maintenance instructions.
 - 2. Proposed method for keeping existing concrete surfaces wet prior to placing hydraulic cement grout.
 - 3. Forming method for fluid grout placements.
 - 4. Curing method for grout.

PART 2 PRODUCTS

2.1 NONSHRINK HYDRAULIC CEMENT GROUT SCHEDULE

- A. Furnish nonshrink hydraulic cement grout of type specified for applications in the following schedule:

	Temperature Range	Maximum Placing Time	
Application	4 to 38 C	20 minutes	Greater than 20 minutes
Machine bases 25 hp or less	II	II	II

2.2 NONSHRINK HYDRAULIC CEMENT GROUT

- A. Nonmetallic, nongas-liberating.
1. Prepackaged natural aggregate grout requiring only the addition of water.
 2. No segregation or settlement of aggregate at fluid consistency at specified times or temperatures.
 3. Test in accordance with ASTM C939 and ASTM C1107, Grade B:
 - a. Fluid consistency 20 to 30 seconds using flow cone method.
 - b. Temperatures of 5, 27, and 38 degrees C.
 4. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
 5. Minimum strength of fluid grout,
 - a. 25 MPa at 1 day.
 - b. 30 MPa at 3 days.
 - c. 52 MPa at 28 days.
 6. Maintain fluid consistency when mixed in 1 to 7 m³ loads in ready-mix truck.
 7. Manufacturers and Products:
 - a. Chemrex, Inc.; Master Flow 928.
 - b. Euclid Chemical Co.; Hi Flow Grout.
 - c. Dayton Superior Corp.; Sure Grip High Performance Grout.
- B. Nonshrink Epoxy Grout:
1. Minimum strength of grout: 62 MPa at 1 day.
 2. Manufacturers and Products:
 - a. Euclid Chemical Co.; E3-HP.
 - b. Dayton Superior Corp.; Sure-Grip Epoxy Grout (J-54).
 - c. Chemrex, Inc.; Masterflow 648 CP.

2.3 DOWELLING GROUT

- A. Hydraulic Cement Grout:
1. Set 45 by Master Builders Inc.
 2. Anchorite II by C C Chemicals Limited.
 3. Epoxy grout:
 - a. Poly-All Epoxy Anchoring System by Ucan Fastening Products.

- b. Sikadur Injection Gel by Sika Canada Inc.
- c. Liquid Roc 500 supplied by Concrete Chemicals.

PART 3 EXECUTION

3.1 NONSHRINK GROUT

- A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative's printed training instructions.
- B. Grouting Machinery Foundations:
 - 1. Use nonshrink hydraulic cement grout except where equipment supplier specifically recommends nonshrink epoxy grout.
 - 2. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by abrasive blasting, chipping, or by mechanical means to remove any soft deleterious material.
 - 3. For nonshrink hydraulic cement grout, thoroughly clean concrete surface and metal surfaces to be in contact with grout to remove all paint, oil, grease, loose rust, and all other foreign matter.
 - 4. For nonshrink epoxy grout, thoroughly clean concrete surface and abrasive blast metal surfaces to be in contact with grout unless grout manufacturer states in writing that abrasive blasting is not necessary.
 - 5. Set machinery in position and wedge to elevation with steel wedges or use cast-in leveling bolts.
 - 6. Form with watertight forms at least 50 mm higher than bottom of plate.
 - 7. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

3.2 GROUTED-IN DOWEL FOR CONNECTING TO EXISTING CONCRETE

- A. Using a Hydraulic Cement Based Dowelling Grout:
 - 1. Drill hole in existing concrete of diameter equal to diameter of dowel bar plus 20 mm.
 - 2. Clean hole of dust and debris.
 - 3. Fill hole to surface with dowelling grout.
 - 4. Install dowel bar and wipe away overflow.
 - 5. Secure dowel bar firmly in position and do not disturb bar for minimum of 24 hours after installation.
- B. Using an Epoxy Type Dowelling Grout:
 - 1. Drill hole and install dowel in accordance with manufacturer's printed instructions.

3.3 ALTERATIONS TO EXISTING CONCRETE

- A. General:

1. Cut out, remove, or modify parts of existing concrete structures, roughen surfaces, cut keys, weld bars, and carry out other items of work as required.
 2. Use satisfactory methods which will not result in damage to equipment or other parts of the structures by vibration, dust, water, or other contaminants.
 3. Verify actual conditions before beginning alterations.
 4. After alterations are done, repair surface defects and damaged areas and finish surface to match adjacent areas.
- B. Finishing of Existing Concrete Surfaces:
1. As a result of alterations where previously exterior faces become interior, abrasive blast and clean entire surface.
 2. Patch surface depressions with sand-cement mortar.
 3. Grind smooth fins and protrusions.
 4. Apply sack-rubbed finish to entire exposed surface to match adjacent interior surfaces.
- C. Refinishing:
1. Refinish cut edges of openings flush and smooth, with a bonding agent and concrete or with a non-shrink non-ferrous pre-blended hydraulic cement grout of same colour as adjacent concrete.
 2. Cut back exposed reinforcing bars 25 mm from the finished surface level. Fill voids at each bar with grout. Grind edges smooth after repairs and modifications have been completed.

3.4 FIELD QUALITY CONTROL

- A. Evaluation and Acceptance of Nonshrink Hydraulic Cement Grout:
1. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
 2. Perform flow cone and bleed tests, and make three 50 mm by 50 mm cubes for each cubic metre of each type of nonshrink grout used. Use restraining caps for cube.
 3. Consistency: Grout with consistencies outside range requirements will be rejected.
 4. Segregation: Grout when aggregate separates will be rejected.
 5. Tests must show that strength attained by non shrink grout cubes is equal to or greater than minimum strength specified.
 6. Strength Test Failures: Remove and replace non shrink grout work failing strength tests.
 7. Perform bleeding test to demonstrate grout will not bleed.
 8. Store cubes at 21 degrees C.
- B. Load Testing of Grouted-in Dowels for Connecting to Existing Concrete:
1. To demonstrate proper installation of grouted-in dowels carry out tension tests on two vertical and two horizontal installations for each size of dowel bar before proceeding further installation.
 2. Apply an axial test load of 75 percent of the yield strength of the dowel bar. Prevent possible failure of the concrete in the vicinity of the dowels tested.

3. Dowel bar will be considered acceptable if there is no slippage of the dowel bar.
4. If improper installation procedures are suspected additional load tests may be ordered.

END OF SECTION