# SECTION 03 01 32

# REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

## PART 1 GENERAL

### 1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. American Society for Testing and Materials International (ASTM):
      a. A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      b. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50mm] Cube Specimens).
      c. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
      d. C348, Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
      e. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
      f. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
      g. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
      h. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
      i. C1202, Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration.
   2. International Concrete Repair Institute (ICRI):
      a. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.

### 1.2 DEFINITIONS

A. Low-Pressure Spray Mortar: Mortar applied by low-pressure spraying, or in small areas by hand troweling.

B. Nonstructural Defects:
   1. Areas with defects that meet the following:
      a. Deemed by Contract Administrator to be superficial.
      b. Not subjected to structural loads or heavy wear.

C. Structural Defects:
   1. Areas that display defects or parts of defect and deemed by Contract Administrator as structural defect and meet any of the following:
      a. Subject to structural loading.
      b. Subject to heavy wear.
      c. Interior of hydraulic structure.
      d. Below-grade structure.

## 1.3 SUBMITTALS

A. Action Submittals:
   1. Product data sheets for each material supplied.
   2. Samples: Mesh reinforcement and mesh anchor.

B. Informational Submittals:
   1. Mortar System:
      a. Manufacturer's installation bulletin.
      b. Manufacturer's recommended fabric size for mesh reinforcement.
   2. Mesh Manufacturer's installation instructions and allowable load criteria.
   3. Written description of equipment proposed for hydrodemolition for surface preparation.
   4. Certificates:
      a. Certificate of Compliance that proposed product system meets or exceeds specified performance criteria when tested in accordance with Article Field Quality Control.
      b. Mortar system Manufacturer's Certificate of Proper Installation.
   5. Statements of Qualification:
      a. Mortar system Manufacturer's Representative.
   6. Mortar system Manufacturer's proposed modified test procedures for ASTM C109/C109M and ASTM C882 test methods.

## 1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Mortar System Applicator:
      a. Experienced applicator endorsed by mortar system Manufacturer.
      b. For low-pressure spray mortar system in lieu of endorsement, complete mortar system Manufacturer's demonstration in accordance with Article Manufacturer's Services.
   2. Mortar System Manufacturer's Representative: As specified in Section 01 43 33, Contractor Field Services.

B. Mockups:
   1. Mortar System Manufacturer's Demonstration:
      a. Schedule time for Manufacturer's demonstration of repair system proposed for Project. Prepare mortar to specified consistency, for testing and placement. Initiate curing on portions of each type of surface to be repaired to include overhead and vertical applications.

b. Prepare surface area in advance of demonstration and obtain Manufacturer's acceptance of preparation for each type of application.
c. Demonstrate:
   1) Mixing and application equipment capabilities and procedures, including the flow of material from sprayer.
   2) Person in charge of low-pressure sprayer, capabilities and ability to follow prescribed application procedures and properly operate equipment and apply surface repair materials.
d. Make compression test samples during demonstration and deliver to an independent testing laboratory for testing at 1, 7, and 28 days. Take a core of the demonstration placement and test for tensile bond at 1 day.

2. For each type of mortar system application demonstration, prepare area of at least 3 metres by 3 metres by the average thickness required for Project.

## 1.5 PREREPAIR CONFERENCE

A. Required Meeting Attendees:
   1. Contractor.
   2. Repair Subcontractor.
   3. Technical representative for repair material Manufacturer.
   4. Contract Administrator.

B. Schedule and conduct prior to incorporation of respective products into Project. Notify Contract Administrator of location and time.

C. Agenda shall include:
   1. Review of field conditions. Conduct field observations of Work to be performed.
   2. Based on above observations, repair material Manufacturer's technical representative shall make material selection and repair method written recommendations.
   3. Technical representative for repair material Manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
   4. Other specified requirements requiring coordination.

# PART 2 PRODUCTS

## 2.1 LOW-PRESSURE SPRAY MORTAR SYSTEM (STRUCTURAL)

A. Mortar:
   1. One component, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.
   2. Materials mixed to a flow of 70 percent at five drops.

B. Cured Mortar Properties:
   1. Slant Shear Bond Strength, ASTM C882 test method modified with no bonding agent at 28 days: 20 MPa minimum.
   2. Compressive Strength, ASTM C109/C109M at 28 days: 40 MPa minimum.

3. Tensile Bond Strength, ASTM C496/C496M at 28 days: 2.0 MPa minimum.
4. Flexural Strength, ASTM C348 at 28 days: 7.5 MPa minimum.
5. Rapid Chloride Permeability, ASTM C1202: 800 coulombs maximum.
6. Drying Shrinkage, ASTM C157 Modified at 28 days: 0.1 percent maximum.
7. System shall not produce a vapor barrier.

C. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.

D. Free of chlorides and other chemicals causing corrosion.

E. Manufacturers and Products:
1. BASF Building Systems; MasterEmaco S488CI.
2. Solhydroc Inc.; Structuroc Sprayable
3. or approved equal in accordance with B8.

## 2.2 BONDING AGENT

A. Epoxy resin concrete cement adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.
1. Mixed Bonding Agent Properties:
a. Pot Life: 75 to 105 minutes.
b. Contact Time: 24 hours.
2. Cured Epoxy Resin Portland Cement Adhesive Properties:
a. Splitting Tensile Strength, ASTM C496/C496M at 28 days: 3.4 MPa minimum.
b. Flexural Strength, ASTM C348: 6.9 MPa minimum.
c. Slant Shear Bond Strength, ASTM 882 at 14 days:
1) 2 Hour Open Time: 20.7 MPa minimum.
2) 24 Hours Open Time: 13.7 MPa minimum.
d. Bonding agent shall not produce a vapor barrier.
e. Compatible with mortar system.

B. Manufacturers and Products:
1. BASF Building Systems; MasterEmaco P 124.
2. or approved equal in accordance with B8.

## 2.3 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

## 2.4 ACCESSORIES

A. Mesh Reinforcement: Welded wire fabric with spacing of wires, and wire size in accordance with ASTM A1064/A1064M, and mortar system Manufacturer’s recommendations.

B. Tie Wire: 16 gauge, galvanized.

C. Mesh Anchors:
   1. Manufacturers and Products:
      a. Powers Fastening, Inc.; Tie-Wire Power-Stud.
      b. Hilti Fastener Systems; HHDCA 1/4Carbon Steel Ceiling Hangers.
      c. UCAN Fastening Products; UCAN Tie Wire Anchor.

D. Finishing Aid:
   1. Manufacturers and Products:
      a. BASF Building Systems; MasterKure ER 50.
      b. Solhydroc Inc.; Solhydkure Plus
      c. or approved equal in accordance with B8.

E. Flexible Cementitious Reinforcing Bar Coating:
   1. Manufacturers and Products:
      a. BASF Building Systems; MasterEmaco P 124.
      b. Sika Canada Inc.; SikaTop Armatec 110 EpoCem.
      c. or approved equal in accordance with B8.

## PART 3 EXECUTION

### 3.1 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques.

B. Remove unsound, honeycombed, deteriorated, or otherwise defective concrete from work areas by high-pressure water blasting machine capable of removing concrete surfaces to a minimum amplitude roughness of 5 millimetres. Where final surface is required to be flush with existing surface remove existing concrete to a depth as required for application of minimum thickness of mortar.

C. Do not use power-driven jackhammers and chipping hammers.

D. If cracks are observed, inform Contract Administrator immediately.

E. To avoid tapered shoulders square edges of patch areas by sawing or chipping approximately 100 millimetres beyond area of unsound or deteriorated concrete.

F. Provide chamfers at concrete corners.

G. Collect and dispose of water from removal operations in manner and location acceptable to the City.

H. Where reinforcing steel is corroded, remove concrete minimum of 25 millimetres clear around reinforcing bar for application and bonding of new mortar to entire surface of exposed reinforcing steel if the following surface conditions exist:
   1. 50 percent or more of reinforcing bar periphery surface is exposed during removal of concrete.

2. 25 percent or more of reinforcing steel periphery surface is exposed during removal of concrete and extent of reinforcing bar corrosion is such that more than 25 percent of material is lost.
3. Visually evident that bond between existing concrete and reinforcement has deteriorated.

I. Clean exposed reinforcing steel of rust and concrete in accordance with recommendations of repair material Manufacturer and in accordance with recommendations ICRI 310.1R.

J. Replace deteriorated reinforcing steel with new reinforcing steel equivalent in cross-sectional area to original reinforcing steel.

K. Coat exposed reinforcing steel with flexible cementitious reinforcing bar coating.

L. Keep areas from which concrete has been removed free of dirt, dust, and water blasting slurry.

M. Remove contaminates from prepared areas before new mortar is applied.

N. Clean surface of laitance and contamination prior to applying mortar.

O. Dampen area to be patched and an area at least 150 millimetres beyond for at least 24 hours to prevent absorption of water from patching mortar to provide saturated surface dry (SSD) condition for existing concrete at time of application of mortar, in accordance with Manufacturer’s printed instructions.

## 3.2 MESH REINFORCEMENT INSTALLATION

A. Provide reinforcement when existing reinforcement is not exposed, and when mortar application is more than 75 millimetres deep, unless otherwise shown on Drawings.

B. Install mesh anchors in accordance with mesh Manufacturer’s instructions.

C. Fasten reinforcement to mesh anchors with tie wire.

D. Lap reinforcement a minimum of one mesh spacing and secure with tie wire at intervals no less than 300 millimetres

## 3.3 LOW-PRESSURE SPRAY MORTAR APPLICATION

A. Mix mortar in mortar-concrete mixer attached to pump-spray equipment for spray application. Mix with a slow speed drill and jiffler type paddle or small mortar type mixer for hand trowel application.

B. After priming substrate per Manufacturer’s recommendations, apply mortar by low pressure spraying equipment, unless noted otherwise.

C. Bonding Agent:
1. Use bonding agent for hand applied areas.

2. Application of repair mortar over the bonding agent shall be completed within time frame recommended by bonding agent Manufacturer.
3. Consult with Manufacturer for optimum and minimum acceptable degrees of surface tackiness of coat.

D. Work mortar firmly and quickly into repair area to consolidate applied mortar. Finish to match adjacent concrete surface.

E. Finish exposed mortar surface with steel trowel finish when finish coat is not applied to smooth even surface matching adjacent concrete. Apply finishing aid at full strength in accordance with Manufacturer's instructions.

3.4 CURING

A. Prior to water curing, water fog spray the applied mortar material in accordance with mortar system Manufacturer's instructions.

B. Commence water curing after mortar system application and when curing will not cause erosion of mortar.

C. Continuously cure mortar system for a period of 7 days.

D. Do not membrane cure, unless method is part of mortar system Manufacturer's instructions and approval is obtained from Contract Administrator.

E. Cure intermediate layers of mortar in accordance with Manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

3.6 MANUFACTURER'S SERVICES

A. Provide mortar system Manufacturer's representative at Site in accordance with Section 01 43 33, Contractor Field Services, for installation assistance, inspection and Certification of Proper Installation, and training of mortar system applicators.

3.7 PROTECTION

A. Protect adjacent surfaces, and equipment, from being damaged by overshooting low-pressure spray mortar.

3.8 CLEANING

A. Remove overshot mortar materials as Work proceeds. Remove from Work waste materials, unsound material from concrete surfaces, material chipped from walls, and water used in preparation of application and finishing.

END OF SECTION

# SECTION 03 01 33

# REPAIR OF HORIZONTAL CONCRETE SURFACES

## PART 1 GENERAL

### 1.1 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
   1. American Society for Testing and Materials (ASTM):
      a. C78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
      b. C109/C109M Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50mm Cube Specimen).
      c. C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      d. C348 C348, Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
      e. C469, Standard Test Method for Static Modulus of Elasticity and Poisson’s Ration of Concrete in Compression.
      f. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
      g. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
      h. C672/C672M, Standard Test Method for Scaling Resistance for Concrete Surfaces Exposed to Deicing Chemicals.
      i. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
      j. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
      k. C928, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.
      l. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
      m. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetrations.
   2. Canadian Standards Association (CSA):
      a. A23.2, Test Methods and Standard Practices for Concrete.

### 1.2 SUBMITTALS

A. Action Submittals:
   1. Product data sheets for each material supplied.

B. Informational Submittals:
   1. Mortar System:
      a. Manufacturer’s installation bulletin.
   2. Certificates:
      a. Certificate of Compliance that repair products are one component with added water only, shrinkage compensated, specially designed for use on horizontal surfaces that are weather exposed, and receive traffic.
      b. Manufacturer's Certificate of Proper Installation.
   3. Statements of Qualification:
      a. Mortar System Applicator.

1.3 QUALITY ASSURANCE

A. Mortar System Applicator: Experienced applicator endorsed by mortar system Manufacturer.

1.4 PACKAGING

A. Package mortar system products in 25-kg moisture-resistance bags, 23-kg pails, or 1500-kg bulk bags.

1.5 PREREPAIR CONFERENCE

A. Required Meeting Attendees:
   1. Contractor.
   2. Repair Subcontractor.
   3. Technical representative for repair material Manufacturer.
   4. Contract Administrator.

B. Schedule and conduct prior to incorporation of respective products into Project. Notify Contract Administrator of location and time.

C. Agenda shall include:
   1. Review of field conditions. Conduct field observations of Work to be performed.
   2. Based on above observations, repair material Manufacturer’s technical representative shall make material selection and repair method written recommendations.
   3. Technical representative for repair material Manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
   4. Other specified requirements requiring coordination.

PART 2 PRODUCTS

2.1 MORTAR SYSTEMS

A. System No. 1:
   1. One component Magnesium- Phosphate Repair Mortar:
      a. Slant Shear Bond, ASTM C882 at 1 day: 13.8 MPa minimum.

b. Application temperature range from -7 to 38 degrees C.
c. Compressive Strength, ASTM C109 at 1 hour: 13.8 MPa, minimum.
d. Resistant to freeze-thaw cycles and deicing chemicals.
e. Sulfate Resistance, ASTM C1012, at 52 weeks: 0.9 percent length change maximum.
f. Flexural Strength, ASTM C78 or CSA A23.2 Test Method A23.2-13C at 1 day: 3.8 MPa minimum.
g. Modulus of Elasticity, ASTM C469 at 7 days: 28.8 GPa.

2. Manufacturer and Product: BASF Building Systems; SET 45.

B. System No. 2:
1. One-component cement based, rheoplastic, high-performance repair mortar system:
a. Slant Shear Bond, ASTM C882 at 1 day: 17 MPa minimum.
b. Direct Shear Bond, at 1 day: 1.0 MPa minimum.
c. Application temperature range from -7 to 29 degrees C.
d. Compressive Strength, ASTM C109 at 1 day: 30 MPa minimum.
e. Resistant to freeze-thaw cycles and deicing chemicals.
f. Modulus of Elasticity, ASTM C469 at 1 day: 26 GPa.
g. Flexural Strength, ASTM C348 at 1 day: 5.8 MPa minimum.
h. Split Tensile Strength, ASTM C496 at 1 day: 5.8 MPa minimum.
i. Scaling Resistance, ASTM C672, and Weight Loss, ASTM C928:
1) At 25 Cycles: CaCl, 0.014 $kg/m^2$ and NaCl, 0.327 $kg/m^2$, maximum weight loss.
2) At 50 Cycles: CaCl, 0.024 $kg/m^2$ and NaCl, 0.410 $kg/m^2$, maximum weight loss.
j. Rapid Chloride Permeability, ASTM C1202 at 28 days: 960 coulombs, maximum.

2. Manufacturer and Product: BASF Building Systems, Toronto, ON; EMACO T415.

C. System No. 3:
1. One-component cement based, rheoplastic, flowable repair mortar system:
a. Slant Shear Bond Strength, ASTM C882 at 7 days: 14.8 MPa minimum.
b. Application temperature range from 4 to 38 degrees C.
c. Compressive Strength, ASTM C109 at 7 days: 40 MPa, minimum.
d. Resistant to freeze-thaw cycles and deicing chemicals.
e. Flexural Strength, ASTM C78 or CSA A23.2 Test Method A23.2-13C at 28 days: 5.3 MPa minimum.
f. High slump design for improved placement, 100 to 150 mm.
g. Rapid Chloride Permeability, ASTM C1202 at 28 days: 650 coulombs, maximum.
h. Sulfate Resistance, ASTM C1012: 0.006 percent length change after 6 months maximum.
i. Modulus of Elasticity, ASTM C469 at 28 days: 40 GPa.

2. Manufacturer and Product: BASF Building Systems, Toronto, ON; EMACO S66-CI.

D. System No. 4:
1. One-component cement based, rheoplastic, flowable, metallic-aggregate repair mortar system:
a. High slump design for improved placement, 125 to 175 mm.

b. Application temperature range from 4 to 32 degrees C.
c. Compressive Strength, ASTM C109
1) At 1 day, 35 MPa minimum.
2) At 7 days, 60 MPa minimum.
d. Abrasion Resistance, ASTM C779, Procedure A at 60 minutes: 0.43 mm.
e. Impact resistance 4 times greater than plain concrete.
f. Density of 44 kg per square metre at a minimum of 12 mm thickness.
2. Manufacturer and Product: BASF Building Systems, Toronto, ON; MASTERTOP ANVIL-TOP 300.
3. Bonding Agent Manufacturer and Product: BASF Building Systems, Toronto, ON; CONCRESIVE Liquid LPL.

E. System No. 5:
1. One-Component, Fast-Setting, Polymer Modified Cementitious Based Mortar System:
a. Slant Shear Bond Strength, ASTM C882 at 7 days: 12.0 MPa, minimum.
b. Flexural Strength, ASTM C348 at 7 days: 6.9 MPa minimum.
c. Abrasion Resistance, ASTM C779 at 60 minutes: 0.84 mm.
d. Splitting Tensile Strength, ASTM C496 at 7 days: 3.0 MPa minimum.
e. Drying Shrinkage, ASTM C596, Modified at 28 days: -0.09 percent.
f. Rapid Chloride Permeability, ASTM C1202 at 28 days: 850 Coulombs, maximum.
g. Compressive Strength, ASTM C109:
1) At 1 day, 17 MPa, minimum.
2) At 7 days, 37.9 MPa, minimum.
3) At 28 days, 51.7 MPa, minimum.
2. Manufacturer and Product: BASF Building Systems, Toronto, ON; EMACO R310 CI.

## 2.2 ACCESSORY MATERIALS

A. Flexible Cementitious Reinforcing Bar Coating: BASF Building Systems, Toronto, ON; MasterEmaco P124.

B. Epoxy Bonding Agent: BASF Building Systems, Toronto, ON; Concresive Liquid LPL.

C. Finishing Aid:
1. Containing a yellow fugitive dye.
2. Manufacturer and Product: BASF Building Systems, Toronto, ON; CONFILM.

D. Membrane Forming Curing Compounds: BASF Building Systems, Toronto, ON; Kure-N-Seal W.

E. Reinforcing Steel: In accordance with Section 03 21 00, Reinforcing Steel.

## 2.3 MIXING

A. In accordance with mortar Manufacturer's instructions:

## PART 3 EXECUTION

### 3.1 APPLICATION

A. System No. 1: Patches, joints, and overlays 12 mm to 75 mm thick. Return to service in 1 hour.

B. System No. 2: Patches, joints, or overlays 12 mm to 75 mm thick. Return to service in 3 hours to 7 days.

C. System No. 3: Patches, joints, or overlays 25 mm or greater in thickness. Return to service in 7 days or more.

D. System No. 4: Heavy-duty joints or overlays 50 mm thick or more. Return to service in 7 days or more.

E. System No. 5:
   1. Patches and overlays 6 mm up to 75 mm thick.
   2. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
   3. Working time 30 minutes at 21 degrees C.
   4. Application temperature range from 7 degrees C to 30 degrees C.

### 3.2 PREPARATION

A. For patch areas 6 mm or deeper, follow the International Association of Concrete Repair Specialists, Surface Preparation Guidelines for the Repair of Deteriorated Concrete Resulting From Reinforcing Steel Oxidation.

B. Identify unsound and deteriorated concrete by sounding techniques.

C. Remove unsound, honeycombed, deteriorated, or otherwise defective concrete from work areas by high-pressure water blasting machine capable of removing concrete surfaces to a minimum amplitude roughness of 5 millimetres, or as shown on Drawings. Where final surface is required to be flush with existing surface remove existing concrete to a depth as required for application of minimum thickness of mortar.

D. If cracks are observed, inform Contract Administrator immediately

E. Do not use power-driven jackhammers and chipping hammers, unless water blasting is not practical or may cause other damage.

F. To avoid tapered shoulders square edges of patch areas by sawing or chipping approximately 50 millimetres beyond area of unsound or deteriorated concrete.

G. Provide chamfers at concrete corners

H. Collect and dispose of water from removal operations in manner and location acceptable to the City.

I. Where reinforcing steel is corroded, remove concrete minimum of 25 millimetres clear around reinforcing bar for application and bonding of new mortar to entire surface of exposed reinforcing steel if the following surface conditions exist:
   1. 50 percent or more of reinforcing bar periphery surface is exposed during removal of concrete.
   2. 25 percent or more of reinforcing steel periphery surface is exposed during removal of concrete and extent of reinforcing bar corrosion is such that more than 25 percent of material is lost.
   3. Visually evident that bond between existing concrete and reinforcement has deteriorated.

J. Clean exposed reinforcing steel of rust and concrete in accordance with recommendations of repair material Manufacturer and in accordance with recommendations ICRI 03730.

K. Replace deteriorated reinforcing steel with new reinforcing steel equivalent in cross-sectional area to original reinforcing steel.

L. Coat exposed reinforcing steel with flexible cementitious reinforcing bar coating.

M. Keep areas from which concrete has been removed free of dirt, dust, and water blasting slurry.

N. Remove contaminates from prepared areas before new mortar is applied.

O. Clean surface of laitance and contamination prior to applying mortar.

P. For areas to receive mortar system Nos. 1, 2, 3, or 5 provide saturated surface dry condition in patch area at time of application for mortar. Dampen area to be patched and an area at least 150 millimetres beyond for at least 24 hours to prevent absorption of water from patching mortar to provide saturated surface dry (SSD) condition for existing concrete at time of application of mortar, in accordance with Manufacturer’s printed instructions.

Q. For areas to receive system No. 4 mortar repair, provide dry surface in patch area at time of application of mortar.

R. Spalled Joints:
   1. Saw cut edge of unsound and deteriorated concrete 25 mm deep and 150 mm back from the old joint.
   2. Remove unsound and deteriorated concrete between saw cut and the joint.
   3. Place wood or fiber spacer to thickness of joint at joint line.

S. Overlays:
   1. Square cut edges to a minimum of 6 mm depth.
   2. Do not feather edge area.
   3. Perform special preparation in accordance with mortar material Manufacturer’s printed instructions, or as recommended in writing by mortar Manufacturer.

## 3.3 BONDING

A. Provide a slurry coat of mortar for mortar system Nos. 1, 2, 3, and 5 in accordance with Manufacturer's instructions.

B. Provide bonding agent for mortar system No. 4 in accordance with Manufacturer's instructions.

## 3.4 INSTALLATION

A. System Nos. 1, 2, 3, or 5:
   1. Remove standing water.
   2. Apply bond coat slurry to prepared surface.
   3. Immediately place mixed repair mortar into prepared area from one side to the other.
   4. Work material firmly into bottom and sides of patch and around reinforcing bars to assure a good bond and encapsulation of reinforcing bars.
   5. Level repair mortar and screed to elevation of existing concrete.
   6. Finish to same texture as existing concrete around patch.
   7. For system No. 5, screed or use self-leveling mixture to obtain a uniform and plane surface.

B. System No. 4:
   1. Blow or vacuum out free water from prepared area.
   2. Apply bonding agent to prepared surface. Do not apply more bonding agent than can be covered with mortar before bonding agent cures, past tacky to the touch.
   3. Immediately place mixed repair mortar into prepared area from one side to the other.
   4. Work material firmly into bottom and sides of patch and around reinforcing bars to assure a good bond and encapsulation of reinforcing bars.
   5. Level repair mortar and screed to elevation of existing concrete.
   6. Finish to same texture as existing concrete around patch.

C. Joint Repair:
   1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will only penetrate surface less than 12 mm.
   2. When repair mortar is cured and ready for use, fill joint in accordance with mortar system Manufacturer's instructions.

## 3.5 FINISHING

A. Spray full strength finishing aid on fresh concrete to prevent rapid drying during hot and windy weather.

## 3.6 CURING

A. System No. 1: Air dry only, do not wet cure.

B. System Nos. 2, 3, 4, or 5:
   1. Provide water-based wax emulsion in accordance with moisture retention requirements of ASTM C309, Type 1 when applied at 6.1 square metres per Litre.
   2. Apply membrane forming curing compound at no more than 6.1 square metres per Litre, as soon as finishing operation is complete.
   3. Apply second coat of curing compound at no more than 6.1 square metres per Litre, after 3 hours, or when first coat is not tacky to the touch.
   4. For potable water structures, wet cure in accordance with Manufacturer’s printed instructions, or a minimum of seven days, whichever is longer.

## 3.7 MANUFACTURERS' SERVICES

A. Provide mortar Manufacturer's representative at site, in accordance with Section 01 43 33, Contractor Field Services, for advice on product selection, surface preparation, mixing and installation assistance, and inspection and certification of proper installation.

## 3.8 TESTS AND INSPECTION

A. Production Samples:
   1. Prepare and cure samples of mixed mortar material from mixer.
   2. Provide minimum of three compressive samples per ASTM C109 for each test specified for each 20 square metres of mortar repair.

B. Chain drag or light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to the old concrete:
   1. Mark hollow areas for removal and replacement.
   2. Saw hollow sounding areas to a new square edge, and reapply mortar as specified.

C. Core Samples:
   1. Locate and mark location of reinforcing bars or mesh.
   2. Core two 65-mm- or 75-mm diameter samples for each 200 square metres of repair work.
   3. Cut cores through cured mortar repair and into base concrete to total depth equal to at least 2.5 times the repair mortar thickness avoiding cutting through reinforcing bars or mesh.
   4. Sawcut cores after removal to trim base concrete thickness to same thickness as mortar so bond line is at center of prepared sample.
   5. Bond samples to steelplates at each end using epoxy bonding agent.
   6. Perform tension testing using calibrated independent test laboratory equipment and eyebolts or threaded connectors tapped and threaded into the baseplate so that the tension load is concentric with the center of the core sample.
   7. Bond line shall sustain minimum of 2.0 MPa in direct tension without failure or movement.

D. Retest mortar repairs that do not meet test requirements.

E. Fill and repair test holes as specified herein.

END OF SECTION

# SECTION 03 05 10

# CAST-IN-PLACE CONCRETE - SHORT FORM

## PART 1 GENERAL

### 1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

### 1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 03 Concrete that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

### 1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. References shall be the current document specified including documents referenced therein. This is the Manitoba Building Code. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. Manitoba Building Code (MBC)

C. Canadian General Standards Board (CGSB)
   1. CAN/CGSB-19.24, Multicomponent, Chemical-Curing Sealing Compound.

D. Canadian Standards Association (CSA)
   1. CAN/CSA A23.1, Concrete Materials and Methods of Concrete Construction.
   2. CAN/CSA A23.2, Methods of Test for Concrete.
   3. CAN/CSA A3000 Compendium for Portland Cement and Supplemental Cementitious Materials.
   4. CAN/CSA G30.5, Welded Steel Wire Fabric for Concrete Reinforcement.
   5. CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement.

### 1.4 SUBMITTALS

A. Shop Drawings
   1. Submit Shop Drawings in accordance with the General Notes stipulated on the Drawings.
   2. Shop Drawings shall bear stamp and signature of qualified Professional Engineer registered or in the Province of the Work.

### 1.5 WASTE MANAGEMENT AND DISPOSAL

A. Separate and recycle waste materials.

B. Ensure emptied containers are sealed and stored safely.

C. Excess concrete shall be removed from site.

D. Designate cleaning area for tools to limit water use and runoff.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. Portland cement with 25 percent maximum fly ash replacement: to CSA A3000 or as stipulated in the Drawing General Notes.

B. Reinforcing bars: to CSA G30.18 and as stipulated in the Drawing General Notes.

C. Other concrete materials: to CAN/CSA A23.1.

### 2.2 MIXES

A. Proportion concrete in accordance with alternative 1 of CSA A23.1.

B. Minimum compressive strength at 28 days shall be as stipulated in the Drawing General Notes.

C. Class of exposure shall be class S-1 for sulphate exposure and class C-2 for chloride exposure as stipulated in CSA A23.1.

D. Nominal maximum size of coarse aggregate shall be as stipulated in the Drawing General Notes.

E. Slump shall be as stipulated in the Drawing General Notes.

F. Air content shall be as stipulated in the Drawing General Notes.

G. Admixtures shall be as stipulated in the Drawing General Notes.

## PART 3 EXECUTION

### 3.1 CONSTRUCTION

A. Do cast-in-place concrete work in accordance with CSA A23.1 and as stipulated in the Drawing General Notes.

3.2 INSERTS

A. Cast in sleeves, ties, slots, anchors, reinforcement, frames, conduit, bolts, waterstops, joint fillers and other inserts required to be built-in. Sleeves and openings greater than 100 mm by 100 mm not indicated, must be approved by Contract Administrator.

3.3 FINISHES

A. Formed surfaces exposed to view shall have a smooth trowelled surface finish in accordance with CSA A23.1.

B. Provide chamfered edges as stipulated in the Drawing General Notes.

3.4 CONTROL JOINTS

A. Cut control joints in duct banks at locations indicated, in accordance with CSA A23.1 and install specified joint sealer/filler.

3.5 CURING

A. Cure and protect concrete in accordance with CSA A23.1.

3.6 SEALING

A. Seal as stipulated in the Drawing General Notes.

3.7 SITE TOLERANCES

A. Tolerances shall be as stipulated in the Drawing General Notes.

3.8 FIELD QUALITY CONTROL

A. Concrete testing shall be to CSA A23.2 by testing laboratory designated and paid for by the City.

END OF SECTION

# SECTION 03 10 00

# CONCRETE FORMWORK AND ACCESSORIES

## PART 1 GENERAL

### 1.1 SUMMARY

A. Requirements for the 66 kV Substation, refer to Section 03 10 10, Concrete Forming and Accessories.

B. Comply with Division 1, General Requirements.

C. This Section forms part of Section 03 30 00, Cast-in-Place Concrete.

### 1.2 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. S269.1, Falsework for Construction Purposes.
      c. S269.2-M, Access Scaffolding for Construction Purposes.
      d. S269.3-M, Concrete Formwork
   2. American Concrete Institute (ACI):
      a. 347, Guide to Formwork for Concrete.
   3. National Lumber Grades Authority (NLGA):
      a. Standard Grading Rules for Canadian Lumber.

### 1.3 DESIGN REQUIREMENTS

A. Design formwork in accordance with CSA S269.1, S269.2-M, and S269.3-M and CSA A 23.1-09 Clause 6.5 Formwork to provide specified finishes.

B. Design formwork and falsework to carry dead loads and construction live loads.

C. When high range water reducer (superplasticizer) is used in concrete mix, design forms for full hydrostatic pressure.

D. Make joints in forms watertight.

E. Design formwork to meet variations from a reference system specified in CSA A23.1-09 Clause 6.4 Construction Tolerances for Cast-in-Place Concrete.

### 1.4 SUBMITTALS

A. Shop Drawings:

1. Submit formwork and falsework drawings bearing seal and signature of a Professional Engineer licensed in the Province of Manitoba for record purpose.
2. Formwork and falsework Shop Drawings will not be reviewed for structural adequacy.
3. Be fully responsible for the design, construction, and maintenance of formwork and falsework.
    a. Show design criteria as specified in CSA A23.1-09 Clause 6.5.2.1.
4. Indicate:
    a. For suspended slabs
        1) Shoring left in place until concrete has reached specified strength.
        2) Re-shoring below slabs or beams supporting shoring above.
            a) Lateral bracing system.
    b. For walls and columns on top of slabs and beams
        1) Shoring left in place until concrete in walls and columns above has reached specified strength.
        2) Lateral bracing system.
5. Layout of panel joints, form liners, and tie hole pattern. Method of sealing form tie hole. Coordinate with details where shown.
6. Double Wall Construction: Show details of double wall forming and premolded joint filler attachment.
7. Two unstamped copies of the Shop Drawings will be returned with Contract Administrator's comments.

B. Product Data Sheets:
1. Submit Manufacturer's product data sheets including materials, allowable loading, installation, application, and maintenance instructions for:
    a. Proprietary scaffolding.
    b. Shoring beams.
    c. Lumber for formwork and falsework.
    d. Plywood for formwork and falsework.
    e. Formwork for curved surfaces.
    f. Tubular column forms.
    g. Void forms (tubes).
    h. Void forms (bio-degradable).
    i. Form release agent.
    j. Form ties.
    k. Controlled permeability form liner.

C. Samples: One each as follows:
1. Form ties.
2. Form liners.

D. Informational Submittals:
1. Statement of qualification for formwork designer.
2. Contractor's Certificate of Proper Installation.

## 1.5 QUALIFICATIONS

A. Formwork, Falsework, and Shoring Designer: An engineer licensed in the province of Manitoba.

## 1.6 QUALITY ASSURANCE

A. Mockup Panels:
   1. Comply with the requirements of Section 03 39 00, Concrete Curing and Finishes
   2. Construct one panel for each form liner type specified.
   3. Construct mockup panels to demonstrate wall finish.
      a. Minimum dimensions 2400 mm by 2400 mm.
      b. Demonstrate sandblasting to show how uniform appearance will be achieved regardless of age of concrete.
   4. Construct panels with specified materials, forming systems, reinforcing details, and leakage prevention techniques.
   5. Show architectural details, joints, form ties, form liners, and reinforcing bar spacers to produce finished surface required.
   6. Test form release agent on one mockup panel to ensure no adverse effects are caused on form or form liner materials.
   7. Cast panels from minimum of 3–cubic metre truck mixer load.
   8. Approved panels establish standard of quality by which concrete work will be judged.
   9. Replace panels if not representative of Work as specified.
   10. Panels may be incorporated into Work if approved by Contract Administrator
   11. Construct additional 2400 mm by 2400 mm panel or use Contract Administrator-selected portion of as-cast wall surface hidden from view to develop and test patching techniques and mixes.

B. Construct additional panels and use to demonstrate repair material and application procedures and obtain approval prior to using material to repair project structures.

# PART 2 PRODUCTS

## 2.1 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: 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.

2. Circular Structures:
    a. Conform forms to circular shape of structure.
    b. Straight panels may be substituted for circular forms provided panels do not exceed 600 mm in horizontal width and angular deflection is no greater than 3-1/2 degrees per joint.
3. Void Forms:
    a. Bio-degradable: Suitable to support construction load with a controlled built-in strength loss.
    b. Manufacturer: Void Form International Ltd.

B. Form Liners:
1. Controlled Permeability Form Liner:
    a. Controlled pore size, maximum 0.08 mm to permit drainage of excess water; water permeability at 200 mm water head of 20 L per square metre per second.
    b. Liner must be noncompressible under wet concrete pressure.
    c. Manufacturer and Product:
        1) Dupont; Zemdrain MD (re-use up to 2 times).
        2) Fibertex; Formtex (do not re-use).

C. Painted Surface Forms: High density overlay plywood surfaces.

D. Form Release Agent:
1. Use form release agent on all cast in place concrete except where form liners is used.
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. BASF; MasterFinish RL 211.
    b. Cresset Chemical Company; Crete-Lease 20-VOC.
    c. W.R. Meadows of Canada Ltd.; Sealtight Duogard.
    d. Euclid Admixture Canada, Inc.; Eucoslip VOX.

E. 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.

F. Form Ties:
1. Material: Steel.
2. Spreader Inserts:
    a. Conical or spherical type.
    b. Design to maintain positive contact with forming material.
    c. Furnish units that will leave no metal closer than 25 mm to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 25 mm depth and sufficient dimensions to permit patching of tie hole.

5. Water Stop Ties: For water-holding structures, below grade structures, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
   a. Integral steel water stop 2.6 mm thick and 16 mm in diameter tightly and continuously welded to tie.
   b. Neoprene water stop 5 mm thick and 24 mm diameter whose center hole is 1/2-diameter of tie, or molded plastic water stop of comparable size.
   c. Orient water stop perpendicular to tie and symmetrical about center of tie.
   d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
   e. Through bolt ties are not permitted for water-holding structures.
6. Through-Bolts: Tapered minimum 25 mm diameter at smallest end.
   a. Not permitted for water-holding structures, below grade structures, pipe galleries, and accessible spaces below finish grade.
7. Elastic Vinyl Plug:
   a. Use in conjunction with through-bolt type form ties.
   b. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.
   c. Manufacturer and Product: Dayton/Richmond Co., A58 Sure Plug.

G. Stay-Form: Form at joints with waterstop as manufactured by AMICO Type No. 66-26 GA minimum.

## PART 3 EXECUTION

### 3.1 FORM SURFACE PREPARATION

A. Remove water, snow, ice, laitance, curing compound, loose soil, 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.

D. Form Liners: Provide liners with full sheets and place seams at horizontal and vertical grooves. Prepare as recommended by Manufacturer.
   1. Use anchorage systems recommended by Manufacturer to anchor liner to formwork.
   2. Do not use form release agent on formwork.

### 3.2 ERECTION

A. General:
   1. Unless specified otherwise, follow applicable recommendations of CSA S269.1, S269.2-M 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, expansion joints and construction joints.
5. Form around pipes, mechanical, and electrical equipment which penetrate the concrete structure.
6. Incorporate frames, castings, pipes, sleeves, and similar items into formwork.
7. Do not re-use damaged formwork which may not provide a uniform consistent finish.
8. Do not re-use controlled permeability form liner when water drainage from the liner has reduced to 75 percent of its first use drainage performance.

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 Contract Administrator's approval of size prior to placement of beveled edge.

C. Wall Forms:
1. Locate form ties and joints in an uninterrupted uniform pattern.
2. Inspect form surfaces prior to installation to assure conformance with specified tolerances.
3. Do not use through-the-wall removable form ties for walls of liquid holding structures and exterior walls below grade.
4. Where excavation shoring system is used as formwork, fasten form tie to shoring in a suitable manner to withstand applied loads.
5. Double Wall Construction:
   a. Joint Filler Attachment:
      1) Use attachments to secure premolded joint filler to one wall only.
      2) Secure premolded joint filler without gaps and separations keeping concrete from second wall pour from penetrating thickness and space occupied by premolded joint filler. Seal all premolded joint filler joints by tapping.
   b. Do not use form ties or other devices permanently penetrating premolded joint filler between walls or produce a rigid connection between walls.
   c. Ensure first cast wall has attained the greater of the wall design concrete strength or the construction strength required, as determine by form design engineer, prior to casting second wall. Determine strength based on field cast and cured test cylinders.

D. Formwork with Form Liners:
1. Construct forms to structurally withstand deflection, movement, leakage, high hydraulic pressures resulting from rapid filling and heavy-high frequency vibration.
2. Lay out form joints and ties in uniform pattern, unless otherwise shown.
3. Use plywood forms when using form liners. Plywood may be of lower finish grade when used in conjunction with form liners.
4. Controlled permeability form liner applications:
   a. Coordinate with Section 03 39 00, Concrete Curing and Finishes.
   b. For liquid holding structures provide liner on both faces except at tunnels and galleries apply liner on wet side only. Provide liners in full sheets. Place seams at regular horizontal and vertical pattern. Prepare as recommended by the Manufacturer.

c. Use anchorage systems recommended by the Manufacturer to anchor liner to formwork. Close anchorage of liner is recommended to prevent wrinkling of the liner.
d. Do not use form release agent on formwork.

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

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

G. Void Forms: Brace void forms to prevent distortion and floatation.

H. Shoring under walls or columns:
1. When constructing concrete walls or columns on top of slabs or beams, provide shoring under these slabs or beams to carry the total construction load.
2. Leave shoring in place until the compressive strength of the concrete in the wall above has reached 75 percent of its specified 28-day compressive strength.

I. Lateral Supports: Where required, brace walls until permanent lateral supports are in place.

J. Formwork at Construction and Expansion Joints: Provide formwork incorporating water stop in joint. Use “Stay-Form” for joints with waterstop. Install Stay-Form as per Manufacturer’s installation instructions and as shown on Drawing details.

## 3.3 FORM REMOVAL

A. Remove wall and column formwork as soon as possible after concrete has attained adequate strength to support its own weight and superimposed loads, without cracking or deflecting excessively in order to facilitate effective finishing, but not earlier than 30 hours after concrete placement if:
1. Concrete is sufficiently hard so as not to sustain damage by form removal operations, and
2. Curing and protection operations are maintained.

B. Elevated Structural Slabs, and Beams: Remove formwork after concrete has reached 75 percent of its specified 28-day compressive strength as determined by field cure test cylinders.

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

## 3.4 MANUFACTURER’S SERVICES

A. Form liner Manufacturer’s Representative to provide installation assistance at Site, and inspection. Contractor to provide inspection report certifying acceptable liner installation in accordance with the Manufacturers’ Specifications.

END OF SECTION

# SECTION 03 10 10

# CONCRETE FORMING AND ACCESSORIES

## PART 1 GENERAL

### 1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

### 1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 03 Concrete that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

### 1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. Manitoba Building Code (MBC)

C. Canadian Standards Association (CSA International)
   1. CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
   2. CSA O86, Engineering Design in Wood.
   3. CSA O121, Douglas Fir Plywood.
   4. CSA O151 Canadian Softwood Plywood.
   5. CSA S269.1, Falsework for Construction Purposes.
   6. CSA S269.3, Concrete Formwork, National Standard of Canada

D. Underwriters' Laboratories of Canada (ULC)
   1. CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

### 1.4 SUBMITTALS

A. Submit Shop Drawings in accordance with the General Notes stipulated on the Drawings.

B. Shop Drawings shall bear stamp and signature of qualified Professional Engineer registered or in the Province of the Work.

## 1.5 DELIVERY, STORAGE AND HANDLING

A. Separate waste and recyclable materials.

# PART 2 PRODUCTS

## 2.1 MATERIALS

A. Materials and resources in accordance with environmentally friendly and sustainable construction methods and materials.

B. Formwork materials:
   1. For concrete without special architectural features, use wood and wood product formwork materials to CSA O121, CAN/CSA O86, and CSA O151.
   2. For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.
   3. Rigid insulation board: to CAN/ULC-S701.

C. Form ties:
   1. For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.

D. Form release agent: non-toxic,], biodegradable, with low VOC,

E. Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 70 and 110s Saybolt Universal, 15 to 24 $mm^2/s$ at 40 degrees C, flashpoint minimum 150 degrees C, open cup.

F. Falsework materials: to CSA S269.1.

G. Sealant: to Section 07 92 10, Joint Sealing.

# PART 3 EXECUTION

## 3.1 FABRICATION AND ERECTION

A. Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with Drawings.

B. Fabricate and erect falsework in accordance with CSA S269.1.

C. Do not place shores and mud sills on frozen ground.

D. Provide site drainage to prevent washout of soil supporting mud sills and shores.

E. Fabricate and erect formwork in accordance with CAN/CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.

F. Align form joints, tape, and make watertight.
   1. Keep form joints to minimum.

G. Use 25 mm chamfer strips on external corners.

H. Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

I. Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
   1. Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

J. Line forms for following surfaces:
   1. Outer face of beams.
   2. If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.

K. Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.

3.2 REMOVAL AND RESHORING

A. Formwork shall be loosened one (1) day after casting.

B. Leave formwork in place for following minimum periods of time after placing concrete.
   1. Seven (7) days minimum for walls and sides of beams.
   2. Seven (7) days minimum for footings.

C. Remove formwork when concrete has reached 70 percent of its design strength or minimum period noted above, whichever comes later.

D. Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.

END OF SECTION

# SECTION 03 15 00

# CONCRETE JOINTS AND ACCESSORIES

## PART 1 GENERAL

### 1.1 SUMMARY

A. This Section forms part of Section 03 30 00, Cast-in-Place Concrete.

B. Section Includes:
1. Cast-in-place concrete accessories including:
   a. Expansion and construction joints for the Work including:
      1) Joints in cast-in-place concrete with a dimensioned separation between the two separate sections of concrete and with or without a waterstop.
      2) Joints in cast-in-place concrete with no separation between the two separate sections of concrete and with or without a waterstop.
   b. Protection of waterstop for future expansion at joints.
   c. Structural bearings, with required hardware.

C. Products Installed But Not Supplied Under the Work of This Section:
1. Location and installation affect the work of this Section. List is not guaranteed as being complete.
   a. Anchor bolts.
   b. Frames for covers and openings.
   c. Equipment castings and pipe fittings.
   d. Embedded plates with anchors.

### 1.2 DEFINITIONS

A. Expansion Joint: Dimensional separation between two separate sections of concrete with or without PVC waterstop to permit movement. Expansion joint may contain shear transfer reinforcing bars across the joint where shown. Space between the sections is filled with specified joint filler and finished with sealant.

B. Construction Joint: Joint in cast in place concrete with no separation between the two separate sections of concrete with or without PVC waterstop. Construction joint in hydraulic structures and below grade structures shall contain PVC waterstop. Construction joint in hydraulic structures and below grade structures against existing structure without PVC waterstops shall contain injection waterstop system.

C. Control Joint: Similar to construction joint with PVC waterstop with nominal reinforcing bars across the joint where shown.

## 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. A23.1-09, Concrete Materials and Methods of Concrete Construction.
      b. A123.3, Asphalt Saturated Organic Roofing Felt
      c. G30.18-M, Carbon Steel Bars for Concrete Reinforcement.
      d. G40.20/21, General Requirements For Rolled or Welded Structural Quality Steel / Structural Quality Steel.
      e. S6, Canadian Highway Bridge Design Code.
   2. American Society for Testing and Materials International (ASTM):
      a. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      c. C920, Standard Specification for Elastomeric Joint Sealants.
      d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
      e. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
      f. D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. Master Plan(s) of Concrete Placements:
      a. Before submitting Shop Drawings of formwork, falsework, and reinforcing bars, submit master plan(s) showing separate concrete placements and locations of construction joints, including proposed construction joints in addition to those indicated on the Drawings.
   2. Joints: Expansion, and Construction
      a. Submit detailed Shop Drawings of each joints type. Submit an elevation or section taken through the plane of the joint showing the walls and slabs at the joint.
   3. PVC Waterstops, Injection Waterstop Systems, Leak Tight Waterproof Strip:
      a. Details of waterstop system, sizes, types, splices, method of securing and supporting waterstop to maintain proper orientation and location during concrete placement.
      b. For PVC Waterstops:
         1) Identify all splices for waterstop
         2) Identify all field and shop splices
         3) Provide details of securing waterstop to reinforcing bar with carrier bars
      c. For Injection Waterstop System:
         1) Indicate the length of hose, attachment mechanism and overlaps
         2) Indicate typical attachment details and spacing of attachment
      d. For Leak Tight Waterproof Strip:
         1) Identify all splices for the Strip
         2) Identify surface preparation and adhesive application

3) Detail cover plate and anchorage
4. Construction Joints: Layout and location for each type.
5. Details of joint fillers, sealant, adhesives, and other appurtenances.
6. Inserts
   a. Detail location, size, and type of concrete inserts.
   b. Indicate coatings, galvanizing, or surface treatments.

B. Samples:
1. PVC water stop splice, joint, and fabricated cross of each size, shape, and fitting of water stop(s).
2. Injection waterstop system.
3. Leak Tight Waterproof Strip
4. Joint fillers.

C. Product Data Sheets
1. Submit three copies of Manufacturer's product data sheets including installation, application, and maintenance instructions for:
   a. PVC waterstops.
   b. Injection waterstop system.
   c. Leak Tight Waterproof Strip
   d. Foamed PVC joint filler.
   e. Preformed joint filler.
   f. Asphalt-impregnated fibre board.
   g. Control joint former.
   h. Control joint sealant.
   i. Adhesive for expansion joint filler.
   j. Concrete inserts.
   k. Polyethylene sheet.

## 1.5 QUALITY ASSURANCE

A. Waterstop Manufacturer Qualifications: Demonstrate 5 years, minimum, continuous successful experience in production of water stops and waterstop systems.

B. Engage Manufacturer’s Representative for on Site supervision during and after installation. Verify that specified products are correctly installed and comply with Manufacturer’s printed instructions.
1. For the following products, Manufacturer’s Representative shall provide certification that the products are suitable for the application and are installed in accordance with the Manufacturer’s warranteed recommendations.
   a. Injection waterstop system.
   b. Leak Tight Waterproof Strip

C. Submit certification of compliance for hot-dip galvanizing in accordance with CAN/CSA-G164-M.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify that delivered materials are in accordance with Specifications and Manufacturer's product data sheets prior to unloading and storing onsite.

B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight.

1.7 WARRANTY

A. Provide 5 year performance warranty for
   1. Injection waterstop system
   2. Leak Tight Waterproof Strip

PART 2 PRODUCTS

2.1 PLASTIC WATERSTOP

A. Extruded from elastomeric plastic compound of prime virgin polyvinyl chloride (PVC) resin free of scrapped material, reclaimed material, or pigment.

B. Factory-made vertical and horizontal crosses, tees, and ells, to form a continuous unbroken seal.

C. Specific Gravity: Approximately 1.37.

D. Shore Durometer Type A Hardness: Approximately 80.

E. Type: Center bulb with parallel ribs or protrusions on each side of strip center.

F. Corrugated or tapered type water stops are not acceptable.

G. Thickness: Constant from bulb edge to outside stop edge.

H. Minimum Weight per Metre of Water Stop:
   1. 2.30 kg for 10 mm by 150 mm.
   2. 3.40 kg for 10 mm by 230 mm.
   3. 3.30 kg for 10 mm/5 mm by 230 mm (split bulb).

I. Fabrications: Use only shop factory fabricated splices for flat ell, flat tee, flat cross, vertical ell, vertical tee and vertical cross. Only butt splices will be permitted in the field.

J. Manufacturers and Products:
   1. Vinylex Corp.; Catalog No. 03250/VIN: No. RB6-38H (150 mm by 10 mm) and No. RB9-38H (230 mm by 10 mm).
   2. Greenstreak Plastic Products; Catalog No. 03150/GRD: Style 732 (150 mm by 10 mm), Style 735 (230 mm by 10 mm), and Style 727 (230 mm by 10 mm/ 5 mm) split bulb.
   3. Durajoint Concrete Accessories; Type 9 (150 mm by 10 mm), and Type 10 (230 mm by 10 mm).

K. Wire Looped Plastic Water Stop:
   1. Furnish as alternative to plastic water stops.
   2. Same material and geometry as plastic water stops.
   3. Furnish with continuous galvanized wire looping at edge, for convenience in positioning and securing stop in place in forms.
   4. Manufacturer and Product: Paul Murphy Plastics; “Wire Stop Water Stop”; geometry numbers ACR 6380, ACR 9380, as shown on Paul Murphy Plastics Co. Drawing No. CCP-120-12M.

L. Retrofit Water Stop:
   1. Manufacturers and Products:
      a. Vinylex Corp.; No. RET638.
      b. Greenstreak Plastic Products; No. 609.

## 2.2 INJECTION WATER STOP SYSTEM

A. Manufacturers and Products:
   1. De Neef Construction Chemicals Inc.; Injecto Water Stop System consisting of Injecto tube with accessories and Hydro Active Flex LV Grout.
   2. Multiurethanes Ltd., DWIN Injectable Tubing System consisting of DWIN injection tubing with accessories and Flexible Water – Reactive Polyurethane Resin.

## 2.3 LEAK TIGHT WATERPROOF STRIP

A. Manufacturers and Products:
   1. Sikadur Combiflex SG System by Sika.
   2. Aqua LINE by Situra.

B. Provide continuous, minimum 6 mm thick stainless steel metal cover plate where leak tight waterproof strip is located on a walking surface. Anchor cover plate to concrete on one side of joint only with stainless steel anchors. Coordinate width and anchorage requirements with leak tight waterproof strip Manufacturer.

## 2.4 TAPE FOR JOINTS

A. Polyethylene or coated paper

B. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape, same width as joint that will adhere to premolded joint material or concrete surface.

## 2.5 PREMOLDED JOINT FILLER

A. Self-expanding Cork:
   1. ASTM D1752, Type III.
   2. Manufacturer and Product: WR Meadows; Self-expanding cork.

B. Bituminous Type: ASTM D994 or D1751.

C. Sponge Rubber:
   1. ASTM D 1752, Type 1 Density not less then 480 kg per $m^3$ by W.R. Grace Ltd.

2.6 PREFORMED CONTROL JOINT

A. One-Piece, Flexible, Polyvinyl Chloride Joint Former:
   1. Manufacturer and Product: Greenstreak Plastic Products; Style Number 854 Transverse Control Joint.

B. Furnish in full-length, unspliced pieces.

2.7 POURABLE JOINT FILLERS

A. Filler for Liquid Containment Structures:
   1. Pourable, two-component, cold-applied compound meeting ASTM C920, Type M, Grade P, Class 25, Use T.
   2. Color: Black.
   3. Manufacturer and Product: W.R. Meadows, Inc.; Gardox.

2.8 STEEL EXPANSION JOINT DOWELS

A. Dowels: CAN/CSA-G40.21-M, Grade 300W round smooth steel bars.

B. Bar Coating: Fusion bonded coating with 100 percent solids epoxy two coats with factory-applied lubricating coating.

| Surface Prep. | Paint Material | Min. Coats, Cover |
|---|---|---|
| SP 10, Near-White Blast Cleaning | Fusion Bonded Coating 100% Solids Epoxy | 1 or 2 coats, 7 MDFT |
| TFE Lube, Shop Applied; Grease Lube Alternative, Field Applied Just Prior to Installation | TFE Lube or Grease Lube | 1 coat, as required |

2.9 STRUCTURAL BEARINGS

A. Structural bearings where shown on Drawings: CAN/CSA-S6; neoprene bearing pads Grade 50 Durometer A.

2.10 ACCESSORIES

A. Joint Sealants: As specified in Section 07 92 00, Joint Sealants.

B. Nonshrink Grout: As specified in Section 03 60 00, Grouting.

C. Roofing Felt: CSA A123.3, Type 2, No. 30 asphalt-saturated felt.

D. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

E. Nails: Galvanized, as required for securing premolded joint filler.

F. Masking Tape: As required to temporarily adhere to concrete at each side of joint to receive filler.

G. Galvanized Rebar at Control Joints: CAN/CSA-G30.18-M Grade 400W prior to galvanizing.

H. Ties for PVC Water Stop: “Hog Rings” or grommets for each edge at 300 mm maximum spacing.

2.11 HOT-DIP GALVANIZING

A. Galvanize steel where noted in accordance with ASTM A123.

B. Galvanize bolts, nuts, washers, and anchor bolts for connections to galvanized steel in accordance with ASTM A123.

C. Complete fabrication, and prepare surfaces of steel by removing weld spatter, flux and residue, burrs, and surface defects before galvanizing.

D. Tap threads of nuts after galvanizing.

PART 3 EXECUTION

3.1 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Construction Joints in Unrestrained Slabs on Ground:
   1. Slabs may be placed continuous from outside edge to outside edge, outside edge to expansion joint, or from expansion joint to expansion joint, unless shown otherwise.

C. Construction Joints in Suspended Slabs Restrained by Connecting Walls:
   1. Place slab in alternate strips with the larger dimension of any single placement no greater than the following:
      a. 10,000 mm for slabs forming part of liquid holding structure.
      b. 15,000 mm for slabs of other than liquid holding structure.
   2. Locate construction joints in suspended slabs near the middle quarter of the spans of slabs and beams, unless indicated otherwise on the Drawings. If a beam intersects a girder at this location, offset the construction joint in the slab and girder by a distance equal to two times the width of the beam.

D. Construction Joints in Girders and Beams:
   1. Construct concrete beams and suspended slabs monolithically, unless indicated otherwise of the Drawings.
   2. If vertical construction joints are required provide shear key, and additional inclined shear reinforcing steel.

E. Construction Joints in Walls:
   1. Locate construction joints:
      a. 2000 mm minimum and 6000 mm maximum away from junction of two or more walls,
      b. Away from a column or beam supported on wall,
      c. Away from nearest edge of an opening wider than 600 mm,
      d. Away from construction joint in a slab on which the wall rests.
   2. Place wall in alternate portions with a distance between vertical construction joints not exceeding the following:
      a. 10,000 mm for walls forming part of liquid holding structure.
      b. 15,000 mm for walls of other than liquid holding structure.

## 3.2 SURFACE PREPARATION

A. Construction Joints:
   1. Prior to placement of abutting concrete, clean contact surface:
   2. Perform cleaning so as not to damage water stop, if one is present.

B. Expansion Joint:
   1. Use wire brush or other motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint from plastic water stop to top of joint.
   2. Use dry high pressure air to remove dust and foreign material, and dry joint.
   3. Prime surfaces as required before placing joint filler.
   4. Avoid damage to water stop.

C. Construction joint with Injection Water Stop System:
   1. Cut key in concrete.
   2. Remove splatter from reinforcing steel and dowels.
   3. Mechanically roughen surface to provide thorough bonding.

D. Structural Bearing Joints:
   1. Fill holes and recesses.
   2. Grind surface smooth.
   3. Clean debris, dirt, dust and foreign materials from concrete surface.

## 3.3 INSTALLATION OF WATER STOPS

A. General:
   1. Install continuous water stop in all construction and expansion joints in walls and slabs of hydraulic structures and below grade structures, unless specifically noted otherwise.
   2. Join water stops at intersections to provide continuous seal.
   3. Locate water stop in the centre of the joint.
   4. Secure water stop in correct position. Tie water stop to reinforcing steel using grommets, “Hog Rings,” or tie wire at maximum spacing of 300 mm. Do not displace water stop during concrete placement.
   5. Repair or replace damaged water stop.
   6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
   7. Joints in Footings and Slabs:
      a. Ensure that space beneath plastic water stop is completely filled with concrete.

b. During concrete placement, make visual inspection of water stop area.
c. Limit concrete placement to elevation of water stop in first pass, vibrate concrete under water stop, lift water stop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic Water Stop:
1. Install in accordance with Manufacturer's printed instructions and as shown on Drawings.
2. Splice in accordance with water stop Manufacturer's printed instructions.
   a. Provide finished splices with cross-sections that are dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
   b. Use only shop made water stop fabrications for all splices except noted below.
   c. Field splice is permitted only for straight butt welds.
3. Wire looped plastic water stop may be substituted for plastic water stop.

C. Injection Water Stop System:
1. Prepare surfaces, and install water stop system in construction joint in accordance with Manufacturer’s printed instructions.
2. Fasten tube to concrete at a spacing of 300 mm.
3. Limit length of grout tube to a maximum of 8000 mm.
4. After the concrete is installed and cured, inject grout in the tube to completely seal the joint and make the joint watertight. Cut ends of tube recessed into concrete surface and plug with cementitious mortar.

D. Leak Tight Waterproof Strip:
1. Prepare surfaces on either side of the joint to achieve textured surface good for epoxy bonding. Repair deteriorated or uneven surfaces.
2. Apply bonding epoxy resin to the substrate and press in the strip evenly by a roller. Ensure the surface is flat and even on both sides.
3. Apply encapsulating epoxy resin over the strip not subjected to movement.
4. Finish epoxied surface evenly with sand cement mortar to match adjacent surface.

## 3.4 EXPANSION JOINT INSTALLATION

A. Self-Expanding Cork Premolded Joint Filler:
1. Install for all water retaining structures
2. Install per Manufacturer’s written instructions.
3. Affix self-expanding cork to face of concrete immediately prior to second placement. Remove coatings and debris. Keep cork dry to prevent premature expansion of cork.

B. Premolded Joint Filler:
1. Installed in dry areas only.
2. Sufficient in width to completely fill joint space.
3. If water stop is in joint, cut premolded joint filler to butt tightly against water stop and concrete face.
4. Precut premolded joint filler to required depth at locations where joint filler or sealant is to be applied.
5. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately shaped material.
6. Vibrate concrete thoroughly along joint form to produce dense, smooth surface.

C. Pourable Joint Filler:
   1. General: Install in accordance with the Manufacturer's written instructions, except as specified below:
      a. Apply primer prior to pouring joint filler.
      b. Fill entire joint above the water stop with joint filler as shown.
      c. Use masking tape on top of slabs at sides of joints; clean spillage. Remove masking tape afterwards.
      d. Coordinate with Section 07 92 00, Joint Sealants.

3.5 PROTECTION OF WATERSTOP FOR FUTURE EXPANSION

A. Provide protection boxes, hardware, and fasteners as required to protect end of waterstop at expansion and construction joints for future expansion.

3.6 CONCRETE INSERTS

A. Install concrete inserts with plastic setting plugs.

B. Leave setting plugs in place.

3.7 STRUCTURAL BEARING

A. Place bearings level and in line at the required elevations.

3.8 SETTING ANCHOR BOLTS FOR EQUIPMENT, AND FITTINGS

A. Receive, handle, and set anchor bolts in accordance with the requirements of the trade supplying them. Protect anchor bolts after setting to maintain correct alignment and level.

3.9 FRAMES FOR COVERS AND OPENINGS

A. Set frames at locations and required elevations.

3.10 EQUIPMENT CASTINGS AND PIPE FITTINGS

A. Set castings and pipe fittings at locations and elevations required.

B. Repair hot-dip galvanized surfaces damaged by welding, cutting, handling during shipping or erection, or otherwise, in accordance with ASTM A780 using a zinc-rich coating. Dry film thickness on repairs to exceed original coating thickness by 25 percent minimum.

END OF SECTION

# SECTION 03 20 00

# CONCRETE REINFORCING

## PART 1 GENERAL

### 1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

### 1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 03 Concrete that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

### 1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. Manitoba Building Code (MBC)

C. American Concrete Institute (ACI)
   1. SP-66, ACI Detailing Manual

D. CSA International
   1. CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
   2. CAN/CSA A23.3, Design of Concrete Structures.
   3. CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.
   4. CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
   5. CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

E. Reinforcing Steel Institute of Canada (RSIC)
   1. RSIC, Reinforcing Steel Manual of Standard Practice.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

A. Submit in accordance with Section 01 33 00, Submittal Procedures.

B. Prepare reinforcement Drawings in accordance with RSIC Manual of Standard Practice.

C. Shop Drawings:
   1. Submit Shop Drawings as stipulated in the Drawing General Notes.
   2. Submit Shop Drawings stamped and signed by Professional Engineer registered or licensed in the Province of the Work.
   3. Detail lap lengths and bar development lengths to CSA A23.3

1.5 QUALITY ASSURANCE

A. Submit in accordance with Section 01 45 16.13, Contractor Quality Control and as described in PART 2 - SOURCE QUALITY CONTROL.
   1. Mill Test Report: upon request, provide Contract Administrator with certified copy of mill test report of reinforcing steel, minimum four (4) weeks prior to beginning reinforcing work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials in accordance with Manufacturer's written instructions.

B. Storage and Handling Requirements:
   1. Store materials off ground in dry location and in accordance with Manufacturer's recommendations in clean, dry, well-ventilated area.
   2. Replace defective or damaged materials with new.

C. Develop Construction Waste Management Plan related to Work of this Section.

PART 2 PRODUCTS

2.1 MATERIALS

A. Substitute different size bars only if permitted in writing by Contract Administrator.

B. Reinforcing steel: billet steel, grade 400, deformed bars to CSA G30.18, unless indicated otherwise.

C. Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.

2.2 FABRICATION

A. Fabricate reinforcing steel in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

B. Obtain Contract Administrator’s written approval for locations of reinforcement splices other than those shown on placing Drawings.

C. Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

## 2.3 SOURCE QUALITY CONTROL

A. Upon request, provide Contract Administrator with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum four (4) weeks prior to beginning reinforcing work.

# PART 3 EXECUTION

## 3.1 FIELD BENDING

A. Do not field bend or field weld reinforcement except where indicated or authorized by Contract Administrator.

B. When field bending is authorized, bend without heat, applying slow and steady force.

C. Replace bars, which develop cracks or splits.

## 3.2 PLACING REINFORCEMENT

A. Place reinforcing steel as indicated on placing Drawings and in accordance with CSA A23.1/A23.2.

B. Prior to placing concrete, obtain Contract Administrator’s review of reinforcing material and placement.

C. Ensure cover to reinforcement is maintained during concrete pour.

## 3.3 CLEANING

A. Progress Cleaning: leave work area clean at end of each day.

B. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

C. Waste Management: separate waste materials for recycling.

END OF SECTION

# SECTION 03 21 00

# REINFORCING BARS

## PART 1 GENERAL

### 1.1 SUMMARY

A. Requirements for the 66 kV Substation, refer to Section 03 20 00, Concrete Reinforcing.

B. Products supplied but not installed under this section:
   1. Reinforcing bars for grouted in dowels.
   2. Reinforcing bars for reinforced masonry.

### 1.2 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. A23.3, Design of Concrete Structures.
      c. G30.18-M, Carbon Steel Bars for Concrete Reinforcement.
      d. W47.1, Certification of Companies for Fusion Welding of Steel.
      e. W186-M, Welding of Reinforcing Bars in Reinforced Concrete Construction.
   2. American Society for Testing and Materials International (ASTM):
      a. A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   3. Reinforcing Steel Institute of Canada (RSIC):
      a. Reinforcement Steel Manual of Standard Practice.
   4. International Conference of Building Officials (ICBO):
      a. ICBO Research Report.

### 1.3 SUBMITTALS

A. Samples and Product Data Sheets:
   1. Submit three samples and three copies of Manufacturer's product data sheets including installation and maintenance instructions for:
      a. Chairs, bolsters, bar supports, and side form spacers.
      b. Dowel bar splicer.
      c. Mechanical splices.

B. Shop Drawings:
   1. Reinforcing Bars:
      a. 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.
      b. Indicate reinforcing bars that form part of an individual concrete placement and reinforcing bars that extend into adjacent placements.

c. 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.
d. 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.
e. 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.
f. For slabs, show a separate plan indicating concrete thicknesses, reinforcing bars, and dowels for walls and columns cast in slab.
g. For walls, show separate elevations indicating concrete thicknesses, reinforcing bars, and dowels for slabs and adjacent walls cast in wall.
h. Do not add new information on previously reviewed Shop Drawings.
i. 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.

2. Submit Shop Drawings of dowel bar splicers detailing locations, size, and type.

C. Quality Control Submittals:
1. 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.
2. Dowel Bar Splicers:
a. Current International Conference of Building Officials (ICBO) Research Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
b. Verification that device threads have been tested and meet requirements for thread quality, in accordance with Manufacturer's published methods.
3. Submit welding certificate in accordance with CSA W47.1 and CSA W186-M.

## 1.4 QUALITY ASSURANCE

A. Welder Qualifications: CSA W47.1 and CSA W186-M certified.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship bundles of reinforcing bars identified by tags containing bar marks along with bar list.

B. Store materials to prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from Site.

PART 2 PRODUCTS

2.1 MATERIALS

A. 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.

B. Mechanical Splices:
   1. Mechanical Threaded Connections: Furnish metal coupling sleeve with internal threads engaging threaded ends of bars, capable of developing in tension or compression 125 percent of yield strength of bar.
      a. Manufacturers and Products:
         1) DB-SAE by Dayton/Richmond by Dayton Superior.
         2) Lenton Form Saver by Erico Canada Inc.
         3) D150 DBR Coupler and DBR Setting-Splice Bar, with size equivalent to DB-SAE, by Dayton Superior Canada Limited.

C. Dowel-in bar: Suitable for existing dowel bar splicer with rolled UNC or tapered threads as required:
   1. DI by Dayton/Richmond by Dayton Superior.
   2. Splice bar by Erico Canada Inc.
   3. D-51, D-52, or D-53, with size equivalent to DI, by Dayton Superior Canada Limited.

D. Welded Wire Reinforcement:
   1. ASTM A1064 wire of 517 MPa (75 ksi) minimum tensile strength.
   2. Furnish flat sheets only, rolled sheets not permitted.

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.
   3. In beams, columns, walls, and slabs exposed to view after form removal: Small concrete blocks made up of same color and strength as concrete being placed around them.
   4. Precast concrete supports of same strength as concrete for reinforcing in concrete placed on grade.
   5. Do not use plastic or stainless steel bar supports or side form spacers.
   6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports are not high or strong enough.

## 2.3 FABRICATION

A. Reinforcing Bars
   1. Comply with CSA A23.1 Clause 6.0 and CSA A23.3.
   2. 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.
   3. Use longest bar possible.
   4. Keep number of splices to a minimum.
   5. Do not weld chairs, bolsters, bar supports, or spacers to reinforcing bars.

B. Reinforcing Splices:
   1. Lap Splices:
      a. Splice by lapping reinforcing bars, unless specified otherwise.
   2. Welded Splices:
      a. Full-penetration direct butt-splice welds in accordance with CSA W186-M and as specified.
   3. Splices in Welded Wire Reinforcement:
      a. Provide lap of 1-1/2 times the spacing of the bar or minimum 200mm.

# PART 3 EXECUTION

## 3.1 PREPARATION

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

B. 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.

C. Coat wire projecting from bar supports with dielectric material, epoxy, or plastic.

## 3.2 REINFORCING BAR INSTALLATION

A. Place reinforcement within tolerances specified in CSA A23.1- 09 Clause 6.6.8 Tolerances for location of reinforcement.

B. Splicing:
   1. Use lap splices, unless otherwise shown or permitted in writing by Contract Administrator.
   2. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar in tension and compression.
   3. Stagger splices in adjacent bars where indicated a minimum of 1500 mm.

C. Dowel Bar Splicers:
   1. Use only in areas specifically approved in writing by Contract Administrator.
   2. Install threaded rods as recommended by Manufacturer with threads totally engaged into coupling sleeve and in accordance with ICBO Research Report.
   3. Install dowel bar splicers with plastic setting plugs.
   4. Lightly grease internal threads in accordance with Manufacturer’s printed instructions.
   5. Maintain minimum edge distance and concrete cover.

D. Mechanical Splices:
   1. Install mechanical splices in accordance with Manufacturer's printed instructions. Request presence of Manufacturer's Representative to verify proper installation.

E. 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.

F. Reinforcement around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut or disrupted for opening. Extend steel reinforcing a standard lap length beyond opening at each end.

G. Welding Reinforcement:
   1. Only Type W bars may be welded.
   2. Do not perform welding until welder qualifications are approved.

H. Dowels Threaded Into Dowel Bar Splicers in Existing Structures
   1. Expose existing dowel bar splicers.
   2. Remove plastic setting plugs and clean threads.
   3. Thread dowel-in bars into the dowel bar splicers and tighten securely to develop required strength in tension and compression.
   4. If the existing dowel bars are damaged or not usable inform Contract Administrator immediately.

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

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

## 3.3 WELDED WIRE REINFORCEMENT INSTALLATION

A. Use only where specifically shown.

B. Extend reinforcement to within 50 mm of edges of slab, and lap splices at least 1-1/2 courses of wire spacing or minimum 200 mm.

C. Tie laps and splices securely at ends and at least every 600 mm with tie wire.

D. Install 15M reinforcing bars at 2000 mm maximum spacing in each direction, supported on chairs, to securely support welded steel wire reinforcement during concrete placement. Ensure the reinforcement remains at intended clearances as specified or indicated.

E. Do not use reinforcement that has been rolled. Install flat sheets only.

3.4 TESTS AND INSPECTION

A. An independent testing agency will be retained by the City to visually inspect and test reinforcing steel welds as specified in Section 05 05 23, Welding-Quality Assurance.

B. An independent testing agency will be retained by the City to inspect each mechanical splice and dowel bar splicer and verify each component is installed in accordance with Manufacturer's instructions and ICBO Research Report.

END OF SECTION

# SECTION 03 30 00

# CAST-IN-PLACE CONCRETE

## PART 1 GENERAL

### 1.1 SUMMARY

A. Requirements for the 66 kV Substation, refer to Section 03 05 10, Cast-in-Place Concrete – Short Form.

B. Comply with Division 1, General Requirements.

C. Comply with requirements of CSA A23.1 and A23.2, except where noted otherwise in this Specification.

D. The following sections form part of this Section:
   1. Section 03 10 00, Concrete Forming and Accessories
   2. Section 03 21 00, Reinforcing Bars
   3. Section 03 15 00, Concrete Joints and Accessories
   4. Section 03 39 00, Concrete Curing
   5. Section 03 60 00, Grouting.

E. 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.

F. Section Includes:
   1. Normal-density concrete.
   2. Fill concrete.
   3. Bonded concrete toppings.
   4. Repair of cracks that develop in concrete.

### 1.2 DEFINITIONS

A. Exposed Concrete: Visible concrete surfaces inside or outside of structures, including surfaces above liquid level.

B. Hydraulic Structures: Liquid holding or containment structures whether above and/or below grade and includes roofs of the containment structure.

C. Habitable structures: Structures that are accessible and may be used for storage or conveyance or utilities.

D. Below Grade structures: Structures that are below or partially below grade. Below grade habitable structures, for water tightness requirements, are considered hydraulic structures.

E. 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 than12 mm in diameter, pinholes, bug holes greater than 4 mm 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.

F. New Concrete: Less than 60 days old.

G. Type of concrete: Project specific concrete type and shall not be confused with type of cements or finishes.

H. Exposure classes of concrete: As defined in Table 1 CSA A23.1-09

I. 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, Test Methods and Standard Practices for Concrete.
      c. A3001, Cementitious Materials for Use in Concrete.
      d. A3002, Masonry and Mortar Cement.
      e. A3003, Chemical Test Methods for Cementitious Materials for Use in Concrete and Masonry.
      f. A3004, Test Methods and Standard Practices for Cementitious Materials for Use in Concrete and Masonry.
      g. A3005, Test Equipment and Materials for Cementitious Materials for Use in Concrete and Masonry.
   2. American Concrete Institute (ACI):
      a. 304.2R, Placing Concrete by Pumping Methods.
   3. American Society for Testing and Materials International (ASTM):
      a. C157 Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
      b. C260, Standard Specifications for Air-Entraining Admixtures for Concrete.
      c. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
      d. C900, Standard Test Method for Pullout Strength of Hardened Concrete.
      e. C1017/C1017M ,Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
      f. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.

## 1.4 PERFORMANCE REQUIREMENTS

A. Concrete for the project is used in 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 waste water plant is 60 to 80 years.

B. Water Tightness:
   1. Concrete as placed for *hydraulic structure* and *below grade habitable structure* shall be watertight.
   2. No visible leaks will be permitted in hydraulic structures and below grade structures.
   3. Roofs of hydraulic structures and below grade structures and other roofs, shall be water tight.
   4. Coordinate leakage test in accordance with requirements of Section 01 35 13, Special Project Procedures.
   5. Repair cracks in *hydraulic structures* and *below grade structures* that are leaking or are damp.
   6. Repair cracks that are wider than 0.4 mm in dry areas. Repair to match surrounding concrete surfaces.
   7. Repair joints that are leaking or are damp.

C. Type of Concrete Class of Exposure and Compressive Strengths.
   1. Normal-density concrete:
      a. Type A: Class of Exposure S-3- 30 MPa at 56 days, W/C 0.45.
      b. Type B: Fill Concrete - Class of Exposure: N;15 MPa at 28 days W/C as required.
      c. Type C: Class of Exposure: C-2 -32 MPa at 28 days w/c 0.45.
      d. Type D: Bonded concrete topping: Class of Exposure: N, 30 MPa at 56 days w/c/ 0.45.
      e. Type E: Bonded concrete topping: Class of Exposure: S-3; 30 MPa at 56 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 degrees 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/m$^3$.

F. Concrete Shrinkage at 28 Day Drying Age:
   1. 0.040 percent maximum for laboratory trial mixes of proposed concrete made with 40 mm aggregate with and without superplasticizer.
   2. 0.045 percent maximum for laboratory trial mixes of proposed concrete made with 20 mm aggregate with and without superplasticizer.
   3. If shrinkage specimen tests for concrete exceed shrinkage limits, modify concrete mix to reduce shrinkage. Repeat tests with new mix.
   4. Test shall be conducted as per modified ASTM C157 as specified herein.

G. Bond Strength for Concrete Topping:
   1. Tensile bond strength between bonded concrete topping and substrate concrete: 1.0 MPa, minimum.

H. Construction Tolerances:
   1. Comply with CSA A23.1-09 Clause 6.4 unless noted otherwise.

I. Concrete Finishes:
   1. As specified in Section 03 39 00, Concrete Curing.

1.5 SUBMITTALS

A. Product Data Sheets:
   1. Submit three copies of Manufacturer's product data sheets including installation, application, and maintenance instructions for:
      a. Chemical admixtures.
      b. Bonding agent.
      c. Crack injection material.
      d. Repair materials.

B. Concrete Mix Design:
   1. Design in accordance with CSA 23.1-09 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. Also identify mix for cold weather and hot weather concreting..
   4. Submit a mix that will not result in segregation when high-slump flowing concrete is used.
   5. Submit detailed plan for cold weather placement, curing and protection of concrete in weather for ambient temperatures below 5 degrees C.
   6. Submit detailed plan for hot weather placements, curing and protection of concrete for ambient temperatures over 27 degrees C.
   7. Concrete mix designs will be reviewed for conformance with requirements of the Specifications and will be returned with Contract Administrator’s comments.

C. Source Quality Control Submittals:
   1. Provide certification that source for fine and coarse aggregates are not subject to deleterious expansion.
   2. Drying shrinkage Test:
      a. Perform laboratory trial mixes of concrete used on project. Make two sets of three specimens for each shrinkage test.
      b. Provide test for Concrete containing:
         1) 40 mm aggregate with or without the use of superplasticer.
         2) 20mm aggregate with or without the use of superplasticer.
      c. Prism Specimen Size: 100 mm by 100 mm by approximately 280 mm with effective gauge length of 250 mm.

d. Specimens: Fabricate, cure, dry and measure as specified in ASTM C157 and modified as follows:
   1) Remove specimens from molds aged 23 hours plus or minus 1 hour after trial batching.
   2) Place immediately in water at 22.8 degrees C plus or minus 2 degrees C for at least 30 minutes.
   3) Measure the specimen within 30 minutes thereafter to determine original length and then submerge in saturated limewater at 22.8 degrees C plus or minus 2 degrees C.
   4) Measure specimens at age 7 days to determine expansion expressed as percentage of original length. Length at age 7 days shall be base length for drying shrinkage calculations (0 days drying age).
   5) Store specimens immediately in humidity control room maintained at 22.8 degrees C plus or minus 2 degrees C and 50 percent plus or minus 4 percent relative humidity for remainder of test.
   6) Measure to determine shrinkage expressed as percentage of base length and report separately for 7, 14, 21, and 28 days of drying after the 7 days of moist curing.
   7) Computing Drying Shrinkage Deformation of Each Specimen:
      a) Difference between base length (at 0 days-drying age) and length after drying at each test age.
      b) Compute average drying shrinkage deformation to nearest 0.001 percent at each test age.
      c) If drying shrinkage of any specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.

D. 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.

E. Concrete Placing Schedule:
   1. Submit concrete placing schedule.
   2. Certificates:
   3. Submit certificate of Ready Mixed Concrete Production Facilities.

4. Submit certification that aggregates will not, nor have the potential to, react with cement to result in deleterious expansion in the concrete.
5. 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.
6. Submit certification that proposed performance mix will produce concrete meeting the requirements of Specifications.
7. 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..
8. 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.
9. Submit certification that bonding agent, if used, will meet the requirements of Specifications.
10. Submit certification that crack injection materials are suitable for continuous submersion and that they will not release toxic materials into the water.

## 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.

C. Pre-placement Meeting:
   1. Hold a meeting at least four weeks prior to the initial placement of concrete to review the detailed requirements for preparing the concrete design mixes, finishes, and procedures for concrete placement for the structures.
   2. Arrange for the attendance at the meeting of the Contract Administrator, The City, and of concrete Subcontractors, Manufacturers, and suppliers including, but not limited, to the following:
      a. Contractor's superintendent.
      b. Laboratory responsible for field quality control.
      c. Ready-mix concrete producer.
      d. Admixture Manufacturer(s).
      e. Concrete pumping and conveying equipment supplier.
      f. Concrete formwork and finishing subcontractors.
   3. Notify the Contract Administrator at least 10 Business Days prior to the scheduled date of the meeting.

4. The Contract Administrator will set an agenda for the meeting at least five Business Days prior to the scheduled date of the meeting.
5. Contractor to provide work plan detailing:
   a. Production plant capacity
   b. Control of traffic on Site
   c. Equipment to be used and availability of stand by
   d. Personnel resources
   e. Quality assurance procedures
   f. Safety on Site
   g. Lighting

## 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.

## 1.8 SITE CONDITIONS

A. Cold Weather Requirements:
   1. The following requirements are in addition to CSA A23.1 -09**,** Clause 7.4.1.5 - Cold Weather Concreting.
   2. Provide temperature-controlled enclosures for areas where concrete is placed whenever ambient air temperature is 5 degrees C or lower.
   3. Protect concrete from the adverse effects of space-heated enclosures including local overheating and combustion products.
   4. Heat mix-water and, if necessary, aggregates when air temperature is at or below, or predicted to go below, 5 degrees C at any time during the next 24 hours.
   5. Maintain temperature of reinforcing bars and forms above 5 degrees C prior to placing concrete.
   6. Maintain temperature of concrete when deposited in forms not less than 15 degrees C and not higher than 25 degrees C.
   7. Maintain temperature of concrete at surfaces at least 10 degrees C for a minimum period of seven days after placing and achieving minimum 75 percent of specified strength. Concrete temperature may then be lowered to ambient air temperature at a rate of 1.2 degree C per hour or 10 degrees C per day.
   8. Keep concrete continuously moist during the curing period.

B. High-temperature Control Requirements:
   1. The following requirements are in addition to CSA A23.1-09, Clause 7.4.1.4 - Hot Weather Concreting.
   2. Limit peak temperature during the curing period to 40 degrees C maximum. Placing temperature that will satisfy this requirement depends on ambient temperature, humidity at the time of placing, thickness of the concrete, and curing methods employed.
   3. Consider use of retarders, low- heat cement, slag replacement, ice in mixing water, pre-cooling of aggregates, cooling of concrete through continuous wet curing, and similar

methods in order to prevent concrete temperatures from exceeding the above specified peak temperature at any time.

4. Monitor concrete temperatures for walls and slabs. After concrete temperature has peaked, control rate of cooling to ambient air temperature at a rate of 1/2 degree C per hour to prevent cracking.
5. Notwithstanding requirements of subparagraphs .1 and .2 above, do not place concrete with temperature higher than 25 degrees C. Concrete with temperature in excess of 25 degrees C on arrival at the Site will be rejected. Remove rejected concrete from the Site.

C. Protection:
1. Protect freshly placed concrete from damage due to construction operations and from cold, heat, rain, snow, running water, drying winds, and any other circumstances which would likely cause deterioration of concrete quality.
2. Use waterproof insulated covers or other suitable materials to enclose freshly placed concrete under these conditions.

D. Frost Protection for Slabs on Grade:
1. Provide continuous protection for slabs on grade to prevent subgrade below from freezing during cold weather. Provide heated enclosures and insulation as required.
2. Sub-grade below completed tanks may be protected against frost by filling with water to a minimum depth of 2000 mm. Place log booms, 200 mm diameter, at maximum spacing of 5000 mm in each direction to abate ice pressures on tank walls. Break ice on formation.

E. 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.

F. Ground Vibration Limitations:
1. Do not place concrete if the vibration level exceeds the limits specified in Section 01 35 13, Special Project Procedures.

G. Backfilling and Service Loads Restrictions:
1. Verify that backfill is not higher than the finished grades indicated.
2. Verify that equipment for backfilling and compaction on top of slab will not impose loads greater than those indicated.
3. Verify that concrete in walls, and slabs, struts, and cross walls, which frame into the walls providing lateral stability, has been placed and has attained specified compressive strength before backfilling against walls or subjecting walls to service loads.
4. Verify that concrete in slabs, and support components have reached specified compressive strengths before backfilling or subjecting slabs to service loads.
5. Verify that the leakage test is successfully completed before backfilling.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland Cements/ Blended Hydraulic Cements:
   1. CSA A23.1 Table 7 Types of blended hydraulic cement:
      a. Type: MSb, HSb. 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, with gradation in accordance with Table 11; rough and angular gravel or crushed stone.
      b. Fine aggregate: CSA A23.1, with gradation in accordance with Table 10; natural sand.

C. Admixtures:
   1. Compatible with each other and with other concrete materials.
   2. Calcium chloride, thio-cyanates, or admixtures containing more than 0.05% chloride ions are not permitted.
   3. Air-entraining admixture: ASTM C260; non-detergent type.
   4. Water-reducing admixtures: ASTM C494; Type A.
   5. Set-retarding admixture: ASTM C494; Type B.
   6. Superplasticizing admixture: ASTM C494; Type F 1or G 2.

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.

2.2 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 A23.1-04 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.
   4. Use high-slump concrete by addition of superplasticizing admixture for walls and columns.

B. Types of Normal-density Concrete:
   1. Type A-Exposure Class S3: Concrete for structures, equipment bases, pipe supports, concrete encased duct banks, benching, and concrete wearing slab, containing reinforcing bars, unless specified otherwise.
   2. Type B-Exposure Class N: Fill concrete and mud mat unless specified otherwise.
   3. Type C-Exposure Class C-2: Concrete for sidewalks, curbs and gutters
   4. Type D: Concrete for bonded topping for precast members
   5. Type E: Concrete for bonded topping for clarifier

C. Mixes for Normal-density Concrete:
   1. Cementing Materials Content:
      a. Provide cementing materials contents as required to meet performance.
   2. Coarse Aggregates:
      a. Gradation in accordance with CSA A23.1, Table 11: Nominal size 40 mm to 5 mm, unless noted otherwise.
      b. Gradation in accordance with CSA A23.1, Table 11 : Nominal size 20 mm to 5 mm, for walls and slabs less than or equal to 300 mm thick, beams, slabs with monolithic beams, columns, and Type B concrete.
      c. Nominal size 10 mm to 2.5 mm, for bonded concrete topping and concrete in steel pans.
   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.
      c. Provide air content category 1 for loading bays, parking areas, and below grade and hydraulic structures, sidewalks curbs and gutters. If high volume supplementary cementing material (HVSCM) is used consult with the Contract Administrator on air content requirements for steel trowelled slabs.
      d. Provide 3 percent maximum air content for concrete forming floors where floor hardener is used.
   4. Admixtures:
      a. Use water-reducing admixture as necessary.
      b. Use superplasticizing admixture with a retarder when required das per Clause 1.8.B.

D. Mix for Bonded Concrete Topping:
   1. Type E concrete Exposure Class S3
   2. Coarse aggregate: CSA A23.1; gravel or crushed stone with gradation in accordance with CSA A23.1, Table 11: nominal size 10 mm to 2.5 mm for topping thickness of 100 mm maximum.
   3. Fine aggregate: CSA A23.1; natural sand.
   4. Admixtures: Use superplasticizing admixture.
   5. Slump: After adding superplasticizing admixture 125 plus or minus 30 mm.
   6. Air Content:
      a. Provide air content category 2, unless noted otherwise.

E. Mix for Filling Openings and Box Outs:
   1. Refer to Specification Section 03 60 00, Grouting.

F. Mix for Wall and Column Grout:
   1. Mix same as for wall and column placements except no coarse aggregate

G. Mix for Pumped Concrete:
   1. Comply with ACI 304.2R and this Specification.
   2. Uniform grading curves for fine and coarse aggregate.
   3. Superplasticizing admixture may be used for pumped concrete.
   4. Do not use admixtures which promote bleeding.
   5. Successfully used previously or for new mix carry out pumping test for successful placement.

## 2.3 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.

# 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, snow, ice, loose soil, laitance, curing compound, wood, and other 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.

C. Bonded Concrete Topping:
   1. Prepare surface of substrate concrete for application of bonded concrete toppings in accordance with the requirements of CSA A23.1-09 Clause 7.6.4. 1 Preparation of Base Course Surface.

## 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.

5. Place concrete between expansion or construction joints in one continuous operation.
6. Submit field review quality control sheet as provided in Section 01 35 13, Special Project Procedures.

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.
2. Do not use high-slump concrete after slump falls below 100 mm for non-flowing concrete and 125 mm for flowing concrete. Where permitted, re-temper in accordance with Manufacturer's printed instructions. Monitor, and correct if required, air content of concrete that has been re-tempered.

D. Adverse Weather Conditions:
1. Make suitable arrangements to prevent damage to fresh concrete, under adverse weather conditions.
2. Do not allow rain, sleet, or snow to increase mixing water or damage surface finish.
3. Plan placement frequency such that lift lines will not be visible in exposed concrete finishes.
4. Provide windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
5. Do not place concrete when ambient temperature is below 5 degrees C or approaching 5 degrees C and falling, without special protection.
6. Do not place concrete against frozen earth or ice, or against forms and reinforcement with frost or ice present.
7. Provide heated enclosures when air temperatures are below 5 degrees C.
8. Maintain surface temperature of concrete above 5 degrees C.
9. External Heating Units:
   a. Vent heating units to atmosphere and do not locally heat or dry concrete. Where water cure is specified, maintain wet condition.
   b. Do not exhaust heater flue gases, directly into enclosed area
10. Temperature Monitoring:
   a. Provide thermocouple wires in concrete for temperature monitoring.

E. Wall and Column Grout:
1. Deposit 75 mm of wall and column grout evenly along horizontal construction joints in bottom of form through an elephant trunk immediately before placing wall or column concrete.

F. Time Interval Between Concrete Placements:
1. Construction Joints: 7 days wet cure continuously.
2. Expansion Joints/Contraction Joints: 1 day.
3. Wait at least 2 hours after depositing concrete in long columns and walls thicker than 200 mm before depositing concrete in beams, girders, or slabs supported thereon.

4. For columns and walls 3 m in height or less, wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon

G. 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. Carefully vibrate concrete around waterstops, to make sure thorough contact.
3. Bend edge of horizontal waterstops slightly upward allowing concrete to flow under and completely fill space below the waterstop. Verify no air is trapped below waterstop and concrete is in contact with waterstop over its entire surface area.
4. Provide sufficient windows in forms or to allow for concrete placement through windows and for visual observation of concrete.
5. Vibration consolidation not to exceed distance of 1 m from point of placement.
6. Do not allow concrete to form cold joints.

H. Bonded Concrete Toppings:
1. Place bonded concrete topping complete with embedded items as indicated on the Drawings within specified tolerances.
2. Comply with the requirements of CSA A23.1-09 Clause 7.6.4.2 Bonding Systems, except that the responsibility of inspecting the substrate concrete surface and selecting a bonding procedure rests with the Contractor.
3. Do not place concrete topping in inclement weather.
4. Verify tensile bond strength of topping with the substrate concrete by testing.
5. Where bonded concrete topping is required after equipment installation, such as for clarifiers, coordinate finishing method and use of equipment for finishing with equipment Manufacturer.

I. Maximum Size of Concrete Placements:
1. Limit size of each placement to allow for strength gain and volume change due to shrinkage
2. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
3. Should placement sequence result in cold joint located below finished water surface, install water stop in joint.

## 3.3 REPAIR OF TEMPERATURE AND SHRINKAGE INDUCED CRACKS

A. Repair cracks in the completed structures employing a 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.

D. Pay for such remedial work at no expense to the City.

3.4 REPAIR OF JOINTS

A. Repair joints in the completed structures employing a polyurethane injection technique to make such joints completely watertight after repair.

B. Remove surface injection materials following completion of work and finish affected areas to match surrounding concrete.

C. Pay for such remedial work at no expense to the City.

3.5 REPAIR OF BONDED CONCRETE TOPPING

A. If topping is poorly bonded or delaminated, remove and replace the topping over the affected area.

B. Pay for such remedial work at no expense to the City.

3.6 CONCRETE BONDING

A. Horizontal Construction Joints in Reinforced Concrete Walls:
   1. Thoroughly clean and saturate surface of joint with water.
   2. Limit wall and column grout placement to maximum 75 mm and minimum 30 mm thickness.
   3. Do not deposit grout from pump hoses or large concrete buckets, unless specified placement thickness can be maintained and verified through inspection windows close to joint.
   4. Limit concrete placed immediately on top of grout to 300 mm thick. Thoroughly vibrate to mix concrete and grout together.

B. 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.

3.7 FIELD QUALITY CONTROL

A. General:
   1. Tests will be made throughout progress of the Work and will be paid for by 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 City, Contract Administrator, Contractor and material supplier within 5 days of availability. For test that fails to meet the Specification inform 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 4 cylinders for each 100 $m^3$ of concrete of each type placed in any day. If the amount placed, for each type of concrete is less than 100 $m^3$ in a day, provide concrete for one standard strength test of 4 cylinders . One cylinder will be tested at 7 days and one at 28 days and two cylinders at 56 days.

C. Concrete Temperature Monitoring:
1. Monitor temperature of concrete starting immediately after placement until the end of 7 days curing period.
2. Record ambient temperature during concrete monitoring period also.
3. Install thermocouple wire sensors in sufficient numbers, into each concrete pour in excess of 20 cubic metres poured in one day, to truly represent the concrete temperatures of the pour.
4. Connect thermocouple wires to central temperature logger that records the temperatures at regular interval of one half hour.
5. Provide records of temperatures daily of previous 24 hours.
6. For each pour, at the end of the curing period, provide temperature graphs of the concrete and the ambient temperature.
7. Consider the use of temperature monitoring system such as Hobo U12 Outdoor Thermocouple Temperature Logger with software and thermocouple wire sensors supplied by Onset Computer Company.

D. Air Content Tests:
1. Testing agency will carry out air content tests in accordance with CSA A23.1 and A23.2.

E. Slump Tests:
1. Testing agency will carry out slump tests in accordance with CSA A23.1 and A23.2.

F. 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 A23.2-14C 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.

G. 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.

H. Bonded Concrete Topping:
1. Bonded concrete topping finishes will be inspected 60 days after completion to verify that a continuous bond between the substrate concrete and the topping has been achieved. The topping will be chain dragged or tapped with a blunt metal object. Detection of a hollow sound will be considered as inadequate bonding.
2. Core each hollow sounding area as requested by the Contract Administrator, to determine bonding adequacy. Pay for coring which may be necessary.
3. Resolve disputes regarding tensile bond strength between substrate concrete and topping, including extent of affected areas by conducting tests.
4. Determine bond strength in accordance with procedure outlined in CSA A23.2-09, CSA A23.2-09 -6B-Determination of bond strength of bonded toppings and overlays and direct tensile strength of concrete mortar and grout.
5. Only tests meeting the strength requirements will be paid by the City. Pay for cost of unsuccessful tests.

I. 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.

END OF SECTION

# SECTION 03 35 00

# CONCRETE FINISHING

## PART 1 GENERAL

### 1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

### 1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 03 Concrete that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

### 1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. The Manitoba Building Code (MBC).

C. Canadian General Standards Board (CGSB).
   1. CAN/CGSB-25.20, Surface Sealer for Floors.

D. CSA International
   1. CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction//Methods of Test for Concrete.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

A. Submit submittals in accordance with Section 01 33 00, Submittal Procedures.

B. Product Data:
   1. Provide Manufacturer's printed product literature and data sheets for concrete finishes and include product characteristics, performance criteria, physical size, finish and limitations.
      a. Provide two (2) copies of WHMIS MSDS in accordance with Section 01 35 29.01, Health and Safety. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content in g/L.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Safety:
1. Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials in accordance with Manufacturer's written instructions.

B. Delivery and Acceptance Requirements:
1. Deliver materials to site in original factory packaging, labelled with Manufacturer's name, address.

C. Packaging Waste Management: remove for reuse of packaging materials for recycling.

PART 2 PRODUCTS

2.1 SEALING COMPOUNDS

A. Surface sealer: to CAN/CGSB-25.20, Type 2 - water based, clear.

2.2 CURING COMPOUNDS

A. Select low curing compounds in accordance with the Drawing General Notes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that concrete surfaces are ready to receive work and elevations are as stipulated on the Drawings.

3.2 CLEANING

A. Progress Cleaning: leave work area clean at end of each day.

B. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

C. Waste Management: separate waste materials for recycling.

3.3 PROTECTION

A. Protect finished installation.

END OF SECTION

# SECTION 03 39 00

# CONCRETE CURING AND FINISHES

## PART 1 GENERAL

### 1.1 SUMMARY

A. Requirements for the 66 kV Substation, refer to Section 03 35 00, Concrete Finishing.

B. Comply with Division 1, General Requirements.

C. This Section forms part of Section 03 30 00, Cast-in-Place Concrete.

### 1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Canadian Standards Association: CSA A23.1-09 Concrete Materials and Methods of Concrete Construction.
   2. American Concrete Institute: ACI 309.2R Identification and Control of Visible Effects of Consolidation on Formed Concrete Surfaces
   3. American Society for Testing and Materials International (ASTM):
      a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      b. C1315, Standard Specification for Liquid Membrane-Forming Compounds having Special Properties for Curing and Sealing Concrete.
   4. American Society of Concrete Contractors: Guide for Surface Finish of Formed Concrete.

### 1.3 DEFINITIONS

A. Aggregate transparency: Mottled surface appearance resulting from deficiencies in the mortar.

B. Air surface voids: Also termed as air pockets or bug holes. Small regular or irregular cavities resulting from entrapped air bubbles in the surface of formed concrete. Air surface voids less than 12 mm in diameter or depth may be acceptable unless specified otherwise.

C. Fin /form streaking: A narrow linear projection on foamed concrete surface resulting from mortar flow into spaces in the formwork.

D. Finish: The texture of a surface after consolidating and finishing operation has been performed.

E. Form offsets: An abrupt change in alignment, either horizontally or vertically.

F. Honeycomb: Condition of irregular voids due to failure of the mortar to effectively fill the space between coarse aggregate particles generally in formed concrete.

G. Laitance: A thin weak brittle layer of cement and aggregate fines on concrete surface.

H. Layer lines: Dark lines on formed surfaces indicating boundary between concrete placements. Cold joints are one form of layer lines.

I. Soundness: A quantitative measure of suitability of concrete to perform as a solid substrate or base for a coating or patching material. Sound concrete substrates usually exhibit strength and cohesiveness without excessive voids or cracks.

J. Subsidence cracking: Tension cracking when concrete settles after initial set.

K. Surface defects: Includes air surface voids, form streaking, sand streaking, aggregate transparency, colour variation, layer lines, cold joints, soft areas, offsets and bulges. Air surface voids or bug holes smaller than 12 mm are not considered as defects as long as they are generally spaced out.

L. Porosity: Small voids that allow fluids to penetrate an otherwise impervious material.

## 1.4 SUBMITTALS

A. Quality Control Submittals:
   1. Manufacturer's Representative and application personnel. Names and phone number.
   2. Manufacturer's certificate of compliance for products furnished.
   3. Statement of Qualifications.
   4. Manufacturer's product service record.
   5. Manufacturer's printed procedures for preparation, product application, protection of finished surface, and post-application cleanup.
   6. Manufacturer's Site specific installation instructions.
   7. Manufacturer's certificate of proper installation.

B. Product Data Sheets
   1. Submit three copies of Manufacturer's product data sheets including installation, application, and maintenance instructions for:
      a. Curing compound
      b. Floor Surface sealer
      c. Non metallic shake on floor hardener
   2. Evaporation retardant.

C. Shop Drawings
   1. Submit Shop Drawings indicating finishes for floors and walls.
   2. Curing methods proposed.

## 1.5 QUALITY ASSURANCE

A. Concrete finishers: Skilled personnel with a minimum of five years proven satisfactory experience finishing concrete of comparable size and scope.

B. Engage Manufacturers' Representative for on Site supervision prior to, during, and after applications. Verify that specified products are correctly applied; amount and finishing procedures comply with Manufacturer's printed instructions for project.

C. Pre-installation Training: Manufacturer-approved training of application personnel and quality control inspectors for finishes.

D. Conference Prior to Slab Placement:
   1. Conducted by Contractor.
   2. Agenda:
      a. Concrete mix design.
      b. Placing techniques.
      c. Finishing techniques.
      d. Product application procedures.
      e. Equipment required for the procedures.
   3. Attendees:
      a. Contractor's superintendent.
      b. Subcontractor's representative involved in concrete placement and finishing.
      c. Resident Inspector from Contract Administrator’s Office.
   4. Note pre-concrete conference is also conducted under Section 03 30 00, Cast-in-Place Concrete.

E. Mockups: Install one 1800 mm by 1800 mm area for each type of floor and wall finish to demonstrate that the material and methods produce a finished product acceptable to the Contract Administrator. Do not commence concrete work until mockups have been accepted by the Contract Administrator.
   1. Mockup will establish the standard of quality for finishes.
   2. Use specified materials at a location designated by Contract Administrator.
   3. Notify Contract Administrator 5 days in advance of commencement of mockup.
   4. Make mockups for following finishes:
      a. Slab
         1) Steel Trowel Finish Type S1
         2) Wood Float Finish Type S2
         3) Nonslip Finish Type S3
         4) Dry shake Floor Hardener Finish Type S3B
         5) Bonded Concrete topping Type S6
      b. Wall
         1) Smooth Wall finishing for Painting Type W2A
         2) Smooth Wall finishing for Waterproofing Type W2B
         3) Controlled Permeability Form Liner Type W3A
         4) Smooth Rubbed Finish Wall W4
         5) Sack Rubbed Finish Type W5

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Prevent deterioration or contamination of stored materials. Deteriorated or contaminated materials will be rejected and must be removed from Site.

1.7 SITE CONDITIONS

A. Comply with special requirements of Section 03 30 00, Cast-in-Place Concrete. for work under cold weather and high temperature conditions.

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. Protect the concrete surface from rapid drying due to high concrete and or ambient temperatures, low humidity, high winds, or heated interiors.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Compound:
   1. ASTM C309 1.

B. Combination Curing and Sealing Compound:
   1. Conforming to ASTM C1315, Clear, non yellowing compound.
   2. Manufacturer and product:
      a. Sika Canada Inc., Florseal WB 25.
      b. BASF: MasterkureCC 1315WB.
      c. Euclid Admixture Canada, Inc.,Super Diamond Clear.
      d. Dayton Superior Canada Limited; Day Chem Cure & Seal: 1315 (J 22).

C. Floor Surface Sealer:
   1. Clear, liquid surface sealer and dust-proofer.
   2. Manufacturer and product
      a. Sika Canada Inc., Sikafloor 3S.
      b. Dayton Superior Canada Limited, Sure Hard Densifier J 17.

D. Evaporation Retardant:
   1. Fluorescent color tint that disappears completely upon drying.
   2. Manufacturers and Products:
      a. BASF; MasterKure ER 50.
      b. Euclid Chemical Co.; Eucobar.

E. Shake on Floor Hardener:
   1. Premixed blend of mineral aggregates, emery particles, wetting and densifying agents, and Portland cement, shake on type;
   2. Manufacturer and Product
      a. Sika Canada Inc.; Sika Emericrete SH,
      b. Euclid Admixture Canada, Inc.; Surflex
      c. BASF; MasterTop 110ABR
      d. Dayton Superior Canada Limited; Quartz Tuff

F. Polyethylene sheet: CGSB 51 GP 51M; 0.15 mm thick.

G. Wet curing materials: Non-staining waterproof curing paper, burlap, or canvas coverings.

H. Bonding agent: Suitable for conditions of service and performance requirements of this Section.

PART 3 EXECUTION

3.1 PREPARATION

A. Review the requirements for applied finishes.

3.2 TOLERANCES

A. General
1. Comply with CSA A23.1- 09, Clause 7.5.1 – Surface Tolerances for slabs and floor.

B. Straightedge Method:
1. Very Flat: Finish tolerance 3 mm in 3000 mm. Surface of base slab applied bonded concrete toppings in clarifiers.
2. Flat: Finish tolerance 5 mm in 3000 mm. Surfaces to receive a vinyl tile, epoxy floor finish or other thin applied floor finish; surfaces to receive ceramic tile or quarry tile on thin set bond coat; surfaces of concrete toppings; and exposed surfaces of concrete floors.
3. Moderately Flat: Finish tolerance 8 mm in 3000 mm. Surfaces to be covered with cladding or to receive insulation, built up roofing, or membrane waterproofing; top of roof slabs of structures, tanks, tunnels, conduits, and similar areas to be covered with backfill.
4. Conventional: Finish tolerance 12 mm in 3000 mm. Surfaces where a bonded concrete topping will be applied.

3.3 CONCRETE FINISHING

A. General:
1. Concrete finishing effort is directly dependent on forming, concrete placing, and curing techniques. Perform finishing procedures until specified finishes are achieved.
2. Complete concrete finishing in areas where mechanical and electrical equipment will be installed prior to commencement of such installation.
3. Where floor slopes and drains are indicated on the Drawings, the floor must be constructed so that water flows to the drain(s) without ponding.

B. Slab or Floor Surfaces:
1. General:
a. Carry out finishing operations in accordance with CSA A23.1 09, Clause 7.5.3 – Initial Finishing of Horizontal Surfaces.
b. Initial finishing operations consist of placing, spreading, consolidation vibrating, and screeding, immediately followed by bull floating, or darbying.
c. Complete leveling and consolidation before free moisture or bleeding of free water rises to top surface.

   d. Provide at least one standby power trowel. Provide sufficient finishers and equipment for the work.
   e. Take precautions necessary to protect the finish against inclement weather.
   f. Commence final finishing operations by finishing the edges and grooving as required followed by floating and trowelling, when concrete has stiffened sufficiently to prevent the working of excess mortar to the surface and is able to sustain foot pressure, and after removing free bleed water.
   g. Straighten with straightedge as often as necessary to achieve specified floor tolerances.
2. Steel Trowel Finish (Type S-1):
   a. 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.
   b. Do not use dry cement or additional water during trowelling. Do not over finish.
   c. 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. Wood Float Finish (Type S-2):
   a. Bring surface to required finish plane.
   b. Wood float concrete surface in accordance with CSA A23.1-09, Clause 7.5.4.2 Floating.
   c. Remove laitance and leave surface clean.
4. Nonslip Finish (Type S-3):
   a. Provide nonslip surface finish by swirl-trowelling the surface in accordance with CSA A23.1-09, Clause 7.5.6.1 – Nonslip Surfaces.
5. Broom Finish (Type S-4):
   a. Provide nonslip surface finish by brooming the surface in accordance with CSA A23.1-09, Clause 7.5.6.1 - Nonslip Surfaces with application of steel or fibre brooms at least 450 mm wide.
   b. Pull broom gently over the surface from side to side at right angles to direction of traffic, with adjacent strokes slightly overlapping.
   c. Produce a broom finish surface free from porous spots, irregularities, depressions, or rough spots with uniform corrugations less than 3 mm.
6. Scratch Finish Type (S-5):
   a. Provide scratch finish. Produce closely spaced grooves approximately 5 mm in accordance with CSA A23.1-09, Clause 7.5.6.2 - Scratch Finish.
7. Bonded Concrete Topping (Type S-6):
   a. Wood float and screed with straightedge float, and finish producing a smooth even surface.
   b. In the clarifiers install bonded concrete topping in accordance with the scraper mechanism supplier's requirements.
   c. Wood float and screed with straightedge connected to the clarifier rake arm.
   d. Produce a smooth even surface throughout
8. Dry shake on powder application (Type S-7):
   a. After initial finishing of horizontal surface as stated above wait for concrete to set to a point that leaves an indentation of 6 to 10 mm when walked upon.
   b. Concrete should be bleed free and can support the weight of the power trowel
   c. Float open the surface.

d. Apply portion of dry shake powder evenly over the area as specified for the application by hand or mechanical spreader.
e. Power float the surface as soon as the dry shake material absorbs the moisture from the base slab.
f. As soon as concrete is hardened sufficiently power trowel to specified Type S-1 finish/Type S-3 finish./
g. Application Rate:
    1) For capillary waterproofing Type S-7A:
        a) Shake apply capillary waterproofing powder at the rate of 1.3 kg/m² on concrete slabs.
        b) Float into surface until uniformity in coverage is obtained.
        c) Comply with Manufacturer's printed instructions for installation and curing.
    2) Floor hardener Type S-7B:
        a) Shake apply floor hardener at a minimum rate of 7.5 kg/m². Apply the shake mix in two separate applications using approximately two thirds of the total amount specified for the first application and the balance for the second.
        b) Apply hardener evenly over the floor surface in one direction.
        c) Machine float just enough to bring moisture completely through the shake and to embed and compact the shake into the base concrete.
        d) Immediately following the floating of the first shake apply the balance of the hardener. Spread shake evenly and in direction perpendicular to the first shake. Float as specified for the first shake.
        e) Comply with Manufacturer's printed instructions for installation and curing.

9. Type S-8 Formed underside of slab
    a. See under formed surfaces.
10. Floor Surface Sealer:
    a. Treat surfaces subject to traffic in the finished structure, such as slabs, stairs, landings, walkways, and similar locations, with a surface sealer except if the surfaces have been cured with dual purpose curing and sealing compound.
    b. Apply sealer in accordance with the Manufacturer's printed instructions.
    c. Do not use surface sealer where bonded finishes or waterproofing is scheduled.

C. Formed Surfaces:
1. General Finishing:
    a. Finish in accordance with CSA A23.1-09, Clause 7.7 Finishing of formed surfaces unless noted otherwise.
        1) Remove face formwork as soon as practical to facilitate repair of surface defects. Remove nails and remnant of form and form oils. Repair surface defects.
        2) Avoid damaging corners and keep edges sharp.
    b. Formwork Tie Holes:
        1) Cut formwork ties 25 mm from surface of concrete.
        2) Make edges of depressions sharp.
        3) Fill depressions with pre-blended non shrink non ferrous grout of same colour as the concrete.

c. Irregularities:
   1) Grind smooth fins, projections, irregularities, and offsets, including those at construction joints.
   2) Where irregularities and offsets cannot be remedied by grinding, chip concrete surface sufficiently deep and apply thoroughly bonded pre-blended non shrink non ferrous grout in similar procedure for repair of honeycomb and defective concrete.
d. Surface Depressions:
   1) Fill surface voids size greater than 12 mm and other surface depressions with a sand cement mortar to match the surface of surrounding concrete.
e. Spalled Corners:
   1) Use repair materials of similar appearance and strength as the surrounding concrete to reconstruct corner to match adjacent corners.
f. Honeycomb, Soft Areas, and Defective Concrete:
   1) Do not repair honeycomb,soft areas, and defective concrete until reviewed by Contract Administrator and permission granted to proceed with the repair work.
   2) Remove honeycomb, soft areas,, and defective concrete down to sound concrete with edges slightly undercut or perpendicular to the surface. Remove a minimum depth of 25 mm. No feather edges are permitted.
   3) Pre-dampen patch area.
   4) Use pre blended non shrink non ferrous grout of same colour as the concrete for exposed concrete surfaces.
   5) Use bonding agents in patching work.
   6) Patch surface slightly higher than the surrounding concrete.
   7) Wet cure patches to equivalent of 10 days minimum.
   8) When patched surface has hardened, rub surface with carborundum brick to a true surface, free from streaks, discolourations, and other imperfections, to match flush with surrounding concrete.
g. Subsidence cracking:
   1) Depending on the depth, locations and function of the structure the repair system may require injection grouting and repairs similar to the defective concrete.

2. Type W -1 (Ordinary Wall Finish)
   a. Carry out general finishing as specified above.
3. Type W -2 (Smooth Wall Finish)
   a. Carry out general finishing as specified above.
   b. Fill air surface voids greater than 3 mm.
   c. Fill nail head depression more than 2mm deep.
   d. Provide wall finish similar to Photo 1 P1 Finish as presented in Guide for Surface Finish of Formed Concrete.
4. Type W -2 A (Smooth Wall Finish for Painting).
   a. Prepare surfaces to Type W-2 finishing standard.
   b. Coordinate finish with the requirement for painting specification
5. Type W -2 B (Smooth Wall Finish for Application of Waterproofing)
   a. Prepare surfaces to Type W-2 finishing standard.
   b. Coordinate finish with the requirement for water proofing specification
6. Type W -3 (Form Liner Finishes)
   a. Type W-3A (Controlled Permeability Form Liner):

1) Coordinate installation and stripping of Form Liner, in accordance with manufactures recommendation and as specified in Section 03 10 00, Concrete Forming and Accessories.
2) Strip forms as soon as possible to ensure the textured surface finish is not damaged
3) Carry out general finishing as specified above.

7. Type W-4 (Smooth Rubbed Finish):
   a. Provide smooth rubbed finish of uniform appearance as specified in CSA A23.1-09, Clause 7.7.4.3 Smooth Rubbed Finish.
   b. Do not commence rubbing or grinding until surface defects are repaired and patching materials are hardened.
   c. Dress surfaces by rubbing or grinding with bricks of carborundum, emery, or other abrasive material to a smooth and even surface to the best grade of architectural concrete work. Wet and rub surfaces until surfaces are even and of uniform smooth appearance. Prevent rounding edges, obliterating the bevel lines on edges and corners, and chipping or cracking the finished edges.
   d. Water cure walls to receive smooth rubbed finish.
   e. If the rubbed finish work cannot start in timely manner then the specified surfaces shall receive Sack- rubbed Finish.
8. Type W-5 (Sack rubbed Finish):
   a. Repair form offsets, sand streaking and layered lines.
   b. Complete Type W2 finishing as specified.
   c. Fill all air surface voids.
   d. Sack rub cement finish to form a smooth finish of uniform appearance as specified in CSA A23.1-09, Clause 7.7.4.4 - Sack Rubbed Finish.
   e. Clean sand for finishing mortar shall pass 630 micron sieve size.
   f. Completed finished surface shall be uniform in appearance free of blemishes, discolorations or surface voids or dimples. Surfaces not meeting the requirements shall be corrected to the satisfaction of the Contract Administrator.
   g. Apply a second coat of sack rubbed cement finish to produce a smooth uniform appearance if required to obtain acceptance.
   h. On completion thoroughly wash the surfaces with clean water
9. Type W-6 (Abrasive blast Finish):
   a. Intent of this procedure is to remove surface skin to depth no more than 1.5 mm, and expose only fine aggregate and air holes near surface, thus producing uniform texture.
   b. Perform abrasive blasting on building or on concrete surfaces in same area of view at same time and obtain uniformity of appearance.
   c. Same person must accomplish abrasive blasting on one structure and on concrete in same area.
   d. Perform abrasive blasting to match approved mockup panel.
   e. Abrasive: Use clean silica sand, free of foreign materials, and supplied in sealed sacks.
   f. Provide samples with different degree of effort for approval of the Contract Administrator.
10. Columns, Beams and Curbs, sides of equipment and pipe saddle supports:
    a. Provide Type W-2 or W-4/5 finish.
11. Type S- 8 (Formed Underside of Slab Finish):

a. When forming is removed, grind off projections on underside of slab and patch defective areas, including small shallow air pockets.

12. Related Unformed Surfaces:
    a. Screed and float tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring in units cast in forms to a texture consistent with that specified for the formed surface unless some different finish is specified elsewhere.

## 3.4 CURING CONCRETE

A. Begin curing immediately following placing and finishing in accordance with CSA A23.1-09 clause 7.4.2 except as noted below.

B. Rate of evaporation is depend on relative humidity, concrete temperature and winds velocity; for rate of evaporation of moisture from concrete surface covered with water see CSA A23.1 appendix D Guidelines for curing and protection.

C. Wet cure for 10 consecutive days at a minimum temperature of 10 degrees C. This requirement supersede CSA23.1 -09 Table 20 Allowable curing regimes.

D. Control initial drying shrinkage and plastic shrinkage for slabs. Provide wind breaks and or shades as required. Provide continuous fog mist when drying shrinkage is likely due to heat or wind. Cover the concrete surface with wet burlap when finishing is complete to start continuous wet curing.

E. Establish the requirements of specified finishes for concrete surfaces before applying curing compound. Verify that curing compound is compatible with applied finishes.

F. Do not use curing compounds on surfaces:
    1. Where concrete or bonded concrete topping will be applied.
    2. Where high temperature control requirements are in force.

G. Formed Surfaces (Walls and Columns)
    1. Wet cure as specified by pouring water between the formwork and concrete surface where possible.
    2. As an alternative, cure as specified above until formwork is removed. Immediately after removal of formwork, provide 24 hours saturation followed by application of curing compound in accordance with Manufacturer's printed instructions.

H. Unformed Surfaces (Slabs)
    1. Cover with absorbent material kept continuously saturated as soon as cement will not wash out or finish be damaged.
    2. As an alternative, wet cure for 24 hours then seal with two complete coats of curing compound applied in accordance with the Manufacturer's instructions. Maintain coating during the curing period.

I. Bonded Concrete Toppings
   1. Wet cure for 10 consecutive days if no bonding agent has been used.
   2. If a bonding agent has been used, employ curing methods for the concrete topping which will produce a cure equivalent to 10 days wet curing and which is in accordance with the bonding agent Manufacturer's printed instructions.
   3. Protect and prevent damage to concrete topping floor finishes. Repair damaged sections.
   4. Protect topping from freezing for a minimum of 14 days after placing.

## 3.5 PROTECTION

A. Keep traffic, which would affect or disturb the curing procedures, off the finished surfaces for a period of seven days.

B. Protect exposed concrete finishes against damage until acceptance of the work by the City. Do not allow rain, sleet, or snow to increase mixing water or damage surface finish.

C. Protect floors which are to receive architectural finishes against contamination by oil, paint, or other deleterious materials which may affect finish.

D. Protect items set into floors from damage. Verify that alignment is not disturbed.

## 3.6 TESTS AND INSPECTION

A. Vapor Transmission Test: Conduct test on new and existing concrete to show that no surface moisture exists prior to application of specified special floor treatment, as follows:
   1. Place polyethylene plastic sheet, minimum 1.2 m by 1.2 m and sealed along four sides with duct tape to prevent moisture transmission by evaporation, over concrete floor area for 24 hours.
   2. Indication of moisture transmission will be apparent by accumulation of moisture on enclosed surface of polyethylene sheet.
   3. Do not apply concrete bonding agent until test results indicate moisture is not being transmitted from concrete surface.

## 3.7 MANUFACTURER'S SERVICES

A. Provide services of Manufacturer's Representative at Site in accordance with in Section 01 43 33, Contractor Field Services, for installation assistance, inspection and certification of proper installation, and training of application personnel.
   1. Technical assistance with design and adjustment of concrete mixes to receive floor finishes and toppings.
   2. Technical assistance to assure and certify application and installation of system being used.
   3. Consultation, direction, and certification of mockup, for full-scale application of floor finishes, and at other times as needed.
   4. Attendance at the conference prior to slab placement to finalize proper methods and procedures.

## 3.8 FIELD QUALITY CONTROL

A. Measure floor flatness and levelness. Report deficiency. Propose method to remediate. Repair as required.

B. Flood the sloped floor surface with water to a depth necessary and allow the water to flow into drain(s). Observe all areas of ponding.Repair all depressed area exceeding the following:
   1. For dry areas ponding depth greater then 3 mm.
   2. For tank floors ponding depth greater then 20 mm.

## 3.9 SCHEDULE OF CONCRETE FINISHES

A. Provide concrete finishes as scheduled:

| Area | Type of Finish | Notes |
|---|---|---|
| EXTERIOR SLABS | | |
| Roof slab/exposed | S-3 | |
| Roof slab/covered with roofing and waterproofing material | S-1 | |
| Water-holding tanks and basins/top of wall | S-1 | |
| Other water-holding tanks and basins | S-1 | |
| Stairs and landings | S-3 | |
| Sidewalks | S-4 | |
| Other exterior slabs | S-2 | |
| Approach slab | S-2 | |
| INTERIOR SLABS | | |
| Buildings, pipe galleries, and other dry areas | S-1 | |
| Hydraulic channels | S-1 | |
| Underside of elevated slabs | S-8 | |
| Equipment bases | S-1 | |
| Surface to receive bonded topping | S-5 | |
| Bonded topping | S-1 | |
| Loading docks | S-7B | |
| Where shake on hardener is applied | S-7B | |
| | | |
| EXTERIOR WALL SURFACES | | |
| Above grade/exposed (above a point 150 mm below finish grade) | W-2 | |

| Area | Type of Finish | Notes |
|---|---|---|
| Above grade/covered with brick veneer or other finish material | W-1 | |
| Backfilled (below a point 150 mm below finish grade) | W-3A | |
| | | |
| INTERIOR WALL SURFACES | | |
| Pipe supports, and equipment bases in dry areas | W-2 | |
| Water-holding tanks, channels, troughs and basins | W-3A | |
| Buildings, pipe galleries, and other dry areas | W-5 | |

END OF SECTION

# SECTION 03 40 00

# PRECAST CONCRETE

## PART 1 GENERAL

### 1.1 GENERAL

A. Requirements for the 66 kV Substation, refer to Section 03 41 00, Precast Structural Concrete.

### 1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. National Building Code of Canada (2010) with 2011 Manitoba Amendments (NBC).
   2. Canadian Standards Association (CSA):
      a. A23.4, Precast Concrete – Materials and Construction.
   3. ASTM International (ASTM):
      a. A167, Standard Specification for Stainless and Heat-Resisting Chromium – Nickel Steel Plate, Sheet, and Strip.
      b. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      c. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   4. Precast/Prestressed Concrete Institute (PCI):
      a. MNL-120, PCI Design Handbook, 7th Edition.

### 1.3 SUBMITTALS

A. Action Submittals:
   1. Sealer for Exterior Surfaces: Product data with mixing/application instructions.
   2. Form Liners: Manufacturer's literature and product data.
   3. Calculations and Technical Data: Proposed details and design calculations for stresses in all critical sections of precast members for all loading conditions including transportation, handling, and erection.
      a. Shop Drawings and design calculations stamped and sealed by a structural engineer registered in the Province of Manitoba.

B. Informational Submittals:
   1. For Precasting Manufacturers Not Listed in Article Quality Assurance:
      a. Experience record on production of precast concrete as shown, with information on precasting plant, that will indicate capability to satisfactorily perform the Work.
      b. Evidence of current PCI plant certification.
   2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
   3. Test Reports:
      a. For precast Manufacturer's concrete test cylinders.
      b. Inspection of installed members.

## 1.4 QUALITY ASSURANCE

A. Qualifications of Precasting Manufacturers:
   1. Manufacturer: Certified to Canadian Precast / Prestressed Concrete Institute (CPCI) Certification Program.
   2. Precast Concrete and Precast Prestressed Concrete: Product of Manufacturer with 3 years' experience producing precast concrete products of quality specified.
   3. Precast Plant: PCI certified plant with current certification.
   4. Calculations stamped and signed by an engineer registered in the Province of Manitoba.

# PART 2 PRODUCTS

## 2.1 MATERIALS

A. Formwork:
   1. One-piece, full-length, and without seams.
   2. As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

C. Cement: As specified in Section 03 30 00, Cast-in-Place Concrete.

D. Pretensioning Strands: Seven-wire, uncoated, stress relieved, ASTM A416, Grade 270.

E. Aggregates: As specified in Section 03 30 00, Cast-in-Place Concrete, for 20 mm maximum size. Furnish of consistent quality, and gradation.

F. Admixtures: As specified in Section 03 30 00, Cast-in-Place Concrete.

G. Embedded Items:
   1. ASTM A167 with minimum yield stress of 227 MPa.
   2. Anchor Studs: Headed anchor studs (HAS), deformed bar anchors (DBA), or threaded studs as manufactured by Nelson Stud Welding Co..
   3. Furnish inserts for lifting, bolting stiffeners, attaching braces, and as otherwise required.
   4. Embedded items must be stainless steel, Type 316L.

H. Grout: Nonshrink, nonmetallic Type II grout as specified in Section 03 60 00, Grouting.

I. Sealer for Exterior Surfaces:
   1. Silane Sealer: One-component penetrating sealer, hydrophilic (isopropyl alcohol as a carrier) with 40 percent active ingredients.
   2. Manufacturers:
      a. BASF.
      b. Euclid Chemical Co.

## 2.2 CONCRETE MIX

A. Precast members: Type A, a specified in Section 03 30 00, Cast-in-Place Concrete, except as noted below.
   1. Design Strength: 35 MPa at 28 days.
   2. Water/Cement Ratio: 0.38 maximum.

B. Topping: Type D, as specified in Section 03 30 00, Cast-in-Place Concrete.

## 2.3 DESIGN REQUIREMENTS

A. Precast items include:
   1. Double tee roof slabs
   2. Bioreactor troughs

B. General:
   1. Design for post-disaster requirements.
   2. Design connections between precast members, and between precast members and other structural components.
   3. Meet applicable sections of PCI MNL-120.
   4. Calculated tension at full service loads shall not exceed six times the square root of design strength except that in wet or corrosive service conditions the calculated tension due to live load and dead load shall not exceed zero.
   5. Limit long-term camber growth to span length divided by 360.

C. Roof slabs:
   1. Design roof as diaphragm. Design for wind loads shown.
   2. Design for spans and superimposed live and dead loads shown plus dead loads of members.
   3. Unfactored superimposed live loads for roof members shall be 2.4 kPa (50 psf) minimum unless noted.
   4. Roof members shall be designed for minimum additional concentrate live load of 1000 kg (2000 lbs) applied anywhere on members unless noted.
   5. Prestress member shall be designed to receive composite topping.
   6. Where precast members are required to be cut for openings, provide steel support below cut openings and transfer loads to adjacent members. Adjacent members shall be designed to support additional loads due to load transfer.
   7. Design precast member for a minimum of 2 hours fire-rating. Provide concrete covers to reinforcing and prestress strands in accordance with NBC requirements.

D. Troughs:
   1. Design trough to dimensions shown. Field verify prior to fabrication.
   2. Design for spans and live load equal to trough full of water, plus dead load of members.
   3. Design for uplift live load equal to empty trough surrounded by tank full of water up to top of wall of trough.

## 2.4 FABRICATION

A. General:
   1. Reinforcing Steel and Pretensioning Strands:
      a. Place in position before concrete is cast.
      b. Keep clean and free from form oil or other substances harmful to bond.
   2. Pretensioning Force, if Used: Determine by elongation and by gauge pressure.
      a. Method: Meet requirements of Prestressed Concrete Institute.
   3. Forms: Produce smooth surfaces.
   4. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of CSA A23.4. Steam curing is permitted.
   5. Release Strength for Pretensioning Method: Minimum 28 MPa, unless otherwise approved.
   6. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

B. Surface Finish for Precast Structural Units: Furnish concrete finish, as specified in Section 03 30 00, Cast-in-Place Concrete, to additional concrete field placed on precast units.
   1. Other Surfaces: Smooth screeded finishes, unless otherwise shown.
   2. Top surface of the precast roof slab is to be raked (roughened) for bonding of composite topping.

C. Sealer:
   1. Apply to surfaces as noted in Room Schedule in accordance with Manufacturer’s instructions.
   2. Protect surface until installed in the Work.
   3. Repair damage as approved by Manufacturer.

D. Embedded Stainless Steel:
   1. Provide embedded stainless steels to be casted into precast members for the support of other trades.
   2. Embedded stainless steels to anchor precast members shall have sufficient strength and shall design to allow movements.
   3. Anchor locations for precast members must be reviewed and approved by Contract Administrator before fabrication and construction.
   4. Stainless steel cast into concrete frames or weld to frames for the purpose of anchoring precast members shall be supplied and installed by this Section.

## 2.5 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precastce with ASTM C31.

B. Test and record concrete strengths.

## PART 3 EXECUTION

### 3.1 ERECTION

A. Verify that anchorage inserts are in correct locations.

B. Handle and erect precast concrete with care as recommended by Manufacturer.

C. Erect precast units plumb, straight, level, square, and in proper alignment.

D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.

E. Field Cutting: Not allowed without prior approval of precast concrete Manufacturer and Contract Administrator.

F. Where insufficient bearing area is provided along edges of walls, beams, columns or support elements, provide bearing area using stainless steel channels, angles, beams, etc. and drill in anchors with sufficient strength to support the precast loads.

### 3.2 PATCHING

A. Mix and place patching mixture to match color and texture of surrounding concrete and to minimize shrinkage.

B. Demonstrate patching method and obtain acceptance and approval.

### 3.3 CLEANING

A. After installation, clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge.

B. Use acid solution only to clean particularly stubborn stains after more conservative methods have been tried unsuccessfully.

C. Use extreme care to prevent damage to precast concrete surfaces and to adjacent materials.

D. Rinse thoroughly with clean water immediately after using cleaner.

### 3.4 FIELD QUALITY CONTROL

A. Inspection:
   1. With Contract Administrator, inspect precast for chips, cracks, and other damage.
   2. Record location and condition of damaged or nonmatching members.

B. Resolution:
   1. Repair damage to satisfaction of Contract Administrator and the City, at no cost to the City.
   2. Remove members with damage or repairs not acceptable to Contract Administrator.

3. Install new acceptable members in place of those removed.
4. Perform reinspection and obtain acceptance by Contract Administrator.

## 3.5 PROTECTION

A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to Site.

B. After erection, protect units from damage.

END OF SECTION

# SECTION 03 41 00

# PRECAST STRUCTURAL CONCRETE

## PART 1 GENERAL

### 1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

### 1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 03 Concrete that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

### 1.3 MEASUREMENT PROCEDURES

A. Measure precast elements in units supplied, delivered, stored and erected.

B. Precast elements measured as individual units, will include cost, supply, delivery, storage and installation of bearing assemblies and removal and patching of erection devices

### 1.4 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. The Manitoba Building Code (MBC)

C. American Society for Testing and Materials International (ASTM)
   1. ASTM A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   2. ASTM A775/A775M, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
   3. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete.

D. Canadian Standards Association (CSA International)
   1. CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
   2. CSA A23.3, Design of Concrete Structures.
   3. CSA A23.4, Precast Concrete - Materials and Construction.
   4. CAN/CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
   5. CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement.

6. CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
7. CSA W47.1, Certification of Companies for Fusion Welding for Steel.
8. CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding Bureau).
9. CSA W59, Welded Steel Construction (Metal Arc Welding) (Metric version).

E. Underwriters' Laboratories of Canada (ULC)
1. CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.5 DESIGN REQUIREMENTS

A. Design precast elements to CSA A23.3 and CSA A23.4 to carry handling stresses.

B. Design precast elements to carry loads specified by the Contract Administrator and all applicable codes.

C. Design connections/attachments of precast elements to load/forces specified by the Contract Administrator.

D. Provide detailed calculations and design Drawings for typical precast elements if requested.

1.6 PERFORMANCE REQUIREMENTS

A. Tolerance of precast elements to CSA A23.4.

1.7 SUBMITTALS

A. Submittals in accordance with Section 01 33 00, Submittal Procedures.

B. Co-ordinate submittal requirements and provide submittals:.
1. Submit Shop Drawings in accordance with the Drawing General Notes and include the following:
2. Methods of handling and erection.
3. Openings, sleeves, inserts and related reinforcement.

C. Shop Drawings: submit drawings stamped and signed by qualified Professional Engineer registered or licensed in the province of the Work.

1.8 QUALIFICATIONS

A. Fabricate and erect precast concrete elements by manufacturing plant certified in appropriate categories according to CSA A23.4

B. Only precast elements fabricated in such certified plants to be acceptable to the Contract Administrator and plant certification to be maintained for duration of fabrication, erection until warranty expires.

C. Welding companies certified to CSA W47.1.

1.9 DELIVERY, STORAGE AND HANDLING

A. Store and manage hazardous materials as required.

B. Deliver, handle and store precast/prestressed units according to Manufacturer's instructions.

C. Waste Management and Disposal:
1. Separate waste materials for recycling.

1.10 WARRANTY

A. Contractor warrants that precast element will not spall or show visible evidence of corrosion of embedded steel and cracking, except for normal hairline shrinkage cracks, in accordance with General Conditions, but for 10 years min.

PART 2 PRODUCTS

2.1 SUSTAINABLE REQUIREMENTS

A. Materials and resources in accordance with environmentally friendly and sustainable construction methods and materials.

2.2 MATERIALS

A. Cement to CAN/CSA A3001, Type GUb.

B. Supplementary cementing materials: with maximum 25 percent Type F fly ash replacement by mass of total cementitious materials to CAN/CSA A3001.

C. Water: to CSA A23.1/A23.2

D. Reinforcing steel: to CAN/CSA G30.18.

E. Hardware and miscellaneous materials: to CSA A23.1/A23.2.

F. Forms: to CSA A23.4.

G. Anchors and supports: to CSA G40.21 Grade 300 W galvanized after fabrication.

H. Welding materials: to CSA W48.

I. Welding electrodes: to CSA W48 certified by Canadian Welding Bureau.

J. Galvanizing: hot dipped galvanizing with minimum zinc coating of 610 $g/m^2$ to ASTM A.

K. Air entrainment admixtures: to ASTM C260.

L. Insulation: extruded polystyrene to CAN/ULC-S701, Type 4.

2.3 MIXES

A. Concrete:
1. Alternative 1 - Performance Method for specifying concrete: to meet Contract Administrator's performance criteria in accordance with CSA A23.1/A23.2.
a. Provide concrete mix to meet following hard state requirements:
1) Durability and class of exposure: S-1 and C-2.
2) Minimum compressive strength at 28 days: 30 MPa.
3) Surface texture: trowel.
b. Provide quality management plan to ensure verification of concrete quality to specified performance.
1) Concrete supplier's certification.

B. Grout:
1. As stipulated in Drawing General Notes

2.4 MANUFACTURED UNITS

A. Manufacture units in accordance with CSA A23.4.

B. Mark each precast unit to correspond to identification mark on Shop Drawings for location with date cast on part of unit not be exposed.

C. Provide hardware suitable for handling elements.

D. Galvanize steel embedments after fabrication.

2.5 FINISHES

A. Finish units to standard grade to CSA A23.4.

2.6 SOURCE QUALITY CONTROL

A. Provide Contract Administrator with certified copies of quality control tests related to this project as specified in CSA A23.4.

B. Provide records from in-house quality control programme based upon plant certification requirements to Contract Administrator for review.

C. Upon request, provide Contract Administrator with certified copy of mill test report of reinforcing steel supplied, showing physical and chemical analysis.

D. Precast plants should keep complete records of supply source of concrete material, steel reinforcement, and provide to Contract Administrator for review upon request.

## PART 3 EXECUTION

### 3.1 ERECTION

A. Do precast concrete work in accordance with CSA A23.4 and CSA A23.3.

B. Do welding in accordance with CSA W59, for welding to steel structures and CSA W186, for welding of reinforcement.

C. Erect precast elements within allowable tolerances.

D. Non-cumulative erection tolerances in accordance with CSA A23-4.

### 3.2 CLEANING

A. Use cleaning methods as reviewed by Contract Administrator before cleaning soiled precast concrete surfaces.

END OF SECTION

# SECTION 03 60 00

# GROUTING

## PART 1 GENERAL

### 1.1 SUMMARY

A. This Section forms part of Section 03 30 00, Cast-in-Place Concrete.

B. Section Includes
1. Grouting including:
   a. Filling tie holes.
   b. Filling openings and blockouts.
   c. Grouting under base plates for equipment and fittings, and structural steel.
   d. Through bolt openings.
   e. Machine bases 26 hp and up.
   f. 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.
3. Miscellaneous concrete work, including:
   a. Treads for steel stairs.
   b. Removable slabs.
   c. Concrete encased conduits (duct banks).
4. Product Installed But Not Supplied Under the Work of This Section
   a. Reinforcing bar for grouted - in bar.

### 1.2 REFERENCES

A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
1. 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.

B. Quality Control Submittals:
1. Manufacturer's printed Instructions:
   a. Adding fibre reinforcing to batching.
   b. Water/Cementing material ratio of grout.
   c. Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance:
   a. Grout free from chlorides and other corrosion-causing chemicals.
   b. Nonshrink hydraulic cement grout properties of Types II and III, verifying expansion at 3 or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Nonshrink grout Manufacturer's Representative.
6. Test Reports for Nonshrink Hydraulic Cement Grout:
   a. Field test reports and laboratory test results for field-drawn samples.
7. Load Test Results for Grouted in Dowels:
   a. Submit load test results of grouted - in dowels.

## 1.4 QUALIFICATIONS

A. Nonshrink Grout Manufacturer's Representative: Authorized and trained grout Manufacturer’s Representative. Minimum of 1 year experience that has resulted in successful installation of grouts similar to those for this Project.

## 1.5 GUARANTEE

A. Manufacturer's guarantee containing disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished will not be accepted.

B. Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective due to faulty materials, as determined by industry standard test methods.

# 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 |
| Filling tie holes | I | I | I |
| Blockouts for gate guides | I or II | | II |
| | | | |
| Column base plates single-storey | I or II | | II |
| Machine bases 25 hp or less | II | II | II |
| | | | |
| Base plates for columns over one storey | II | II | II |
| | | | |
| Through-bolt openings | II | II | II |
| Machine bases 26 hp and up | III | III | III |
| Baseplates and/or soleplates with vibration, thermal movement, etc. | III | III | III |

## 2.2 NONSHRINK HYDRAULIC CEMENT GROUT

A. Type I:
1. Nonmetallic and nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Test in accordance with ASTM C1107:
   a. Flowable consistency 140 percent, five drops in 30 seconds, in accordance with ASTM C230.
   b. Flowable for 15 minutes.
4. No bleeding of grout at maximum allowed water.
5. Minimum strength of flowable grout,
   a. 20 MPa at 3 days,
   b. 35 MPa at 7 days,
   c. 48 MPa at 28 days.
6. Manufacturers and Products:
   a. BASF.; MasterFlow 100.
   b. Euclid Chemical Co.; NS Grout.
   c. Dayton Superior Corp.; 1107 Advantage Grout.

B. Type II:
1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. No segregation or settlement of aggregate at fluid consistency at specified times or temperatures.
4. 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.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout,
   a. 25 MPa at 1 day
   b. 30 MPa at 3 days
   c. 52 MPa at 28 days.
7. Maintain fluid consistency when mixed in 1 to 7 $m^3$ loads in ready-mix truck.
8. Manufacturers and Products:
   a. BASF.; MasterFlow 928.
   b. Euclid Chemical Co.; Hi-Flow Grout.
   c. Dayton Superior Corp.; Sure-Grip High Performance Grout.

C. Type III:
1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. No segregation or settlement of aggregate at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C939 and ASTM C1107, Grade A:
   a. Fluid consistency 20 to 30 seconds using flow cone method.
   b. Temperatures of 5 and 38 degrees C.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout,
   a. 28 MPa at 1 day
   b. 35 MPa at 3 days
   c. 62 MPa at 28 days.
7. Maintain fluid consistency when mixed in 1 to 7 $m^3$ loads in ready-mix truck.
8. Manufacturer and Product:
   a. BASF; MasterFlow 885
   b. Euclid Chemical Co.: Hi Flow Metallic Grout

D. 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-55).
   c. BASF; Masterflow 649.

## 2.3 DOWELLING GROUT

A. Hydraulic Cement Grout:
1. MasterEmaco T 545 by BASF.

B. Epoxy grout:
1. Sikadur Injection Gel by Sika Canada Inc.
2. Liquid Roc 500 by Mkt Fastening.

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. Form Tie or Through-Bolt Holes: Provide nonshrink hydraulic cement grout, Type I and II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes coordinate dry pack dense grout application with vinyl plug.

C. 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 in accordance with Section 03 39 00, Concrete Curing.

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.

D. Existing Reinforcing Dowels Encased in Lean Concrete or Lime Mortar:
1. Break out existing encasement and expose reinforcing dowels. Clean individual bars to bare metal by abrasive blast cleaning. Straighten bars as required.
2. Report any missing or damaged reinforcing bars to the Contract Administrator before proceeding further.

## 3.4 SCHEDULE OF MISCELLANEOUS CONCRETE WORK

A. Removable Slabs:
1. Provide concrete slabs with minimum two stainless steel lifting inserts per slab. Provide matching stainless steel plugs and lifting rings for each insert.
2. Weld end of reinforcing bars to cross bars.

B. Concrete Encased Conduits (Ductbanks):
1. Provide Type A concrete, as specified in Section 03 30 00, Cast-in-Place Concrete, complete with formwork, reinforcement, and accessories as required.
2. Secure conduits to prevent flotation or displacement during concrete placement. Take corrective actions immediately if conduits become displaced during concrete placement.
3. Carefully place and consolidate concrete around individual conduits.
4. Protect conduits against breakage, damage, or disturbance during placing and consolidating of concrete.

C. Filling Openings and Box-outs:
1. Fill openings and box-outs in walls with concrete made with non shrink non-ferrous pre-blended hydraulic cement grout, placed under pressure.
2. Inject epoxy grout at the interfaces if required to make concrete watertight.

## 3.5 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. For large grout applications make three additional cubes and one more flow cone test. Include bleed test for each additional cubic metre of nonshrink grout placed.
   4. Consistency: Grout with consistencies outside range requirements will be rejected.
   5. Segregation: Grout when aggregate separates will be rejected.
   6. Tests must show that strength attained by non shrink grout cubes is equal to or greater than minimum strength specified.
   7. Strength Test Failures: Remove and replace non shrink grout work failing strength tests.
   8. Perform bleeding test to demonstrate grout will not bleed.
   9. Store cubes at 21 degrees C.
   10. Independent testing laboratory to prepare, store, cure, and test cubes.

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. Perform additional tests at no cost to the City.
   5. Tension Test Failures: Remove and replace dowels failing tension test.

## 3.6 MANUFACTURER'S SERVICES GENERAL

A. Coordinate demonstrations, training sessions, and applicable Site visits with grout Manufacturer's Representative.

B. Provide and conduct onsite, demonstration and training sessions for all measurements, testing, application, and curing for each type and type of nonshrink grout.

C. Ensure necessary equipment and materials are available for demonstration.

D. Training:
   1. Training is required for all Type II and Type III and epoxy grout installations.
   2. Grout Manufacturer's Representative to train Contractor to perform grout work.
   3. Establish location at Site and schedule time for grout Manufacturer's demonstration and training session of proposed nonshrink grouts. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, e.g., baseplates and tie holes to provide actual on-the-job training.
   4. For nonshrink hydraulic cement grout, use minimum of five bags for each grout Type II and Type III. Mix grout to fluid consistency and conduct flow cone and two bleed tests,

make a minimum of six cubes for testing of two cubes at 1, 3, and 28 days. Use remaining grout for final Work.

5. Training to include methods for curing grout.
6. Mix and demonstrate patching through-bolt holes and blockouts for gate guides, and similar items.
7. Transport test cubes to independent test laboratory and obtain test reports.

END OF SECTION

# SECTION 03 64 24

# CRACK REPAIR POLYURETHANE INJECTION GROUTING

## PART 1 GENERAL

### 1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section. Conforms to the latest edition:
   1. International Concrete Repair Institute (ICRI): Concrete Repair Manual
   2. ASTM International (ASTM):
      a. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics

### 1.2 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Crack Injection: Method of sealing or repairing cracks by injecting a polymer.

C. Defective Area: Cracks defined in Section 03 30 00, Cast-in-Place Concrete.

### 1.3 SUBMITTALS

A. Action Submittals:
   1. Physical and chemical properties for polyurethane grout.
   2. Technical data for metering, mixing, and injection equipment.
   3. Survey plans and elevations of proposed repair including locations, length, material, and procedures.

B. Informational Submittals:
   1. Manufacturer’s recommended surface preparation procedures and application instructions for polyurethane injection.
   2. Manufacturer’s Certificate of Compliance: Certified test results for each batch of polyurethane.
   3. Statements of Qualification for Polyurethane grout:
      a. Manufacturer’s Representative.
      b. Injection applicator.
      c. Injection pump operating technician.

## 1.4 QUALITY ASSURANCE

A. Qualifications for Repair Installation Staff:
   1. Manufacturer's Site Representative:
      a. Capable of instructing successful methods for repair concrete structures utilizing polyurethane injection process.
      b. Understands and is capable of explaining technical aspects of correct material selection and use.
      c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
   2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
      a. Licensed and certified by polyurethane Manufacturer.
      b. Minimum 3 years' experience in successful polyurethane injection for at least 3,000 linear meters of successful crack injection including 600 linear meters of wet crack injection to stop water leakage.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Package adhesive material in new sealed containers and label with following information:
   1. Manufacturer's name.
   2. Product name and lot number.
   3. ANSI Hazard Classification.
   4. ANSI recommended precautions for handling.
   5. Mix ratio by volume.

B. Storage and Protection: Store polyurethane containers at ambient temperatures below 32 degrees C and above 7 degrees C in a cool, dry and well ventilated area. Keep away from ignition source.

# PART 2 PRODUCTS

## 2.1 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:
   1. BASF The Chemical Company, Building Systems; MasterInject Series.
   2. Sika Corp.; SikaFix Series.
   3. Material selected shall meet the following properties:
      a. Minimum elongation shall be 25 percent using ASTM D1623 test method.
      b. Shrinkage shall be 0 percent using ASTM D1623 test method.
      c. Water absorption shall be less than 1 percent using ASTM D1623 test method.

## 2.2 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

## PART 3 EXECUTION

### 3.1 GENERAL

A. Use shall be limited to non-structural locations as determine by Contract Administrator.

B. Perform crack repair after removing defective surface materials and after performing surface preparation, but prior to applying surface repair material unless otherwise noted.

### 3.2 PREPARATION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with polyurethane Manufacturer's instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter to expose the full extent of cracks.

D. Do not use acids and corrosives for cleaning, unless neutralized prior to injecting.

E. Provide work platforms as requied.

### 3.3 APPLICATION

A. Entry Ports:
1. Establish openings for polyurethane entry along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow polyurethane to penetrate to the full thickness of the member.
3. Drill injection holes at 45-degree angle to the surface and on alternate sides of a crack, where possible, to intercept cracks. Space holes as close as required. Maximum spacing is 300 mm on center.
4. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
5. Install injectors into drilled holes
6. Apply surface sealer along crack surface as required.
7. Flush cracks with clean water.

B. Polyurethane Injection:
1. Inject polyurethane grout into cracks in accordance with Manufacturer's written instructions.
2. Start injection into each crack at lowest injector on a vertical face and at one end on a horizontal surface.
3. Continue injection until pure uncontaminated material flows out from adjacent injectors.
4. Cap injectors and proceed to adjacent injectors until all injectors have been filled.

C. Finishing:
1. Upon completion, remove injectors, surface seal material and injection polyurethane runs and spills from concrete surfaces.

2. Thoroughly clean the concrete surfaces of excess grout material.
3. Patch injection holes.
4. Finish surface to match surrounding concrete.

3.4 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two adhesive components, and inject mixture into crack.

B. Pumps:
1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.
3. Capable of immediate compensation for changes in resins.
4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed components at pressures up to 1.4 MPa (200 psi), plus or minus 5 percent, and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain polyurethane Manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 1.1 MPa (160 psi).

F. Ratio/Pressure Check Device:
1. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
2. Pressure gauge capable of sensing pressure behind each valve.

3.5 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two polyurethane component delivery lines to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 1.1 MPa (160 psi).
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 1.0 MPa (150 psi) within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.

b. When injection work as stop for more than 45 minutes.

6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

END OF SECTION

# SECTION 03 65 00

# CONCRETE TANK INSPECTION

## PART 1 GENERAL

### 1.1 SUMMARY

A. This section specifies requirements for an internal inspection of one train of the four existing high purity oxygen (HPO) reactors. The existing HPO reactors are to be repurposed into biofilter tanks and fermenter tanks under the work of this Contract.

B. Results of the inspection will be used in conjunction with the Drawings and specifications to form the basis of repair and restoration requirements for the application of chemical-resistant coatings for the fermenter and biofilter tanks. Refer to 09 98 00 Ferment and Biofilter Coatings.

C. Comply with Division 1, General Requirements.

### 1.2 BACKGROUND

A. The four existing HPO reactors are to be rehabilitated and repurposed into three Biofilter Cells and two Primary Sludge Fermenter Trains as shown on Contract Drawings. The two northern tanks were constructed in 1971. The two tanks to the south were constructed in 1993. All four tanks have identical configurations and layouts. The closed tanks are constructed of reinforced concrete. The tanks operate close to atmospheric pressure. The tanks contain activated sludge and are aerated with pure oxygen. The liquid levels in the trains remain constant during operation. During the construction phase of this Contract one of the two older tanks will be temporarily shut down to allow for an internal inspection of cell 1, 2, 3 and 4 as named on Contract Drawing 1-0102-SGAD-D002.

### 1.3 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Canadian Standards Association (CSA):
      a. A23.3R, Design of Concrete Structures.
   2. American Concrete Institute (ACI):
      a. 201.1R, Guide for Conducting a Visual Inspection of Concrete in Service.
      b. 224.1R, Causes, Evaluation, and Repair of Cracks in Concrete Structures.
   3. American Society for Testing and Materials (ASTM):
      a. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      b. C114, Standard Test Methods for Chemical Analysis of Hydraulic Cement.

### 1.4 DEFINITIONS

A. Inspector: Competent, qualified entity hired by the Contractor who will be performing the inspection of the concrete tanks. The inspector shall have demonstrable experience in the

condition assessment of reinforced concrete tanks utilized in the wastewater treatment industry. All work done by the Inspector shall be reviewed by a structural engineer, licensed in the Province of Manitoba, either employed or contracted by the Inspector.

## 1.5 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01 33 00, Submittal Procedures, and shall include the following information:
   1. Action Submittals:
      a. Written description of equipment and methods proposed for cleaning of tanks prior to the inspection.
      b. Written description of work plan to be employed for the inspection of the tanks. Work plan shall include, but not be limited to, health and safety plans, equipment to be used, sampling locations, and tests (including test methods) to be performed.
      c. Inspection Report
         1) The report shall bear the seal and signature of a structural engineer licensed in the Province of Manitoba.
         2) Additional Inspection Report requirements are outlined in paragraph 3.5 of this Section.
         3) Submit a draft Inspection Report within two months of inspection.
         4) Submit a final Inspection Report within four months of inspection.
   2. Informational Submittals:
      a. Inspector Qualifications:
         1) List of references substantiating experience. Include 5 past projects similar in nature and scope. Include project name, location, names of the owner and Contract Administrator and summary of services provided. Projects shall be limited to work within the water and waste treatment industry.

## 1.6 QUALITY ASSURANCE

A. Inspector’s Experience: Minimum 5 years of demonstrable experience performing condition assessments, structural design, and/or corrosion mitigation design of similar wastewater treatment assets to the one being inspected under this specification.

B. The Contractor is responsible for cleaning of the tank to allow for a complete inspection. Coordinate and confirm with the Inspector that surfaces are adequately cleaned prior to inspection.

C. The Contractor is responsible for ensuring the inspection work is performed as per the requirements of specification 01 35 29.01 Health and Safety.

## 1.7 PRE-INSPECTION MEETING

A. Prior to beginning inspection work, schedule a meeting and be prepared to discuss the following subjects, as a minimum:
   1. Required schedule.
   2. Sequence of critical path work items.
   3. Inspection Methodology.
   4. Use of site, access, office and storage areas, security, and temporary facilities.

5. City coordination requirements.
6. Safety plan.

B. Attendees shall include:
1. The City's representatives.
2. Contractor's resident superintendent and other representatives.
3. Inspector's representative.
4. Contract Administrator's representative.
5. Others as appropriate.

C. The meeting shall occur a minimum of 5 working days prior to The City's planned shutdown.

1.8 POST-INSPECTION MEETING

A. After the draft Inspection Report has been submitted schedule a meeting to discuss inspection findings and other contents. The timing of the meeting shall be as required to allow sufficient time for completion of the final Inspection Report.

B. Attendees shall include:
1. The City's representatives.
2. Contractor's representatives.
3. Inspector's representative.
4. Contract Administrator's representative.
5. Others as appropriate.

1.9 REGULATORY REQUIREMENTS

A. Meet applicable federal, provincial, and local requirements for inspection and testing activities.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Provide adequate lighting, access and ventilation prior to and during inspection as required to meet all applicable safety and health regulations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TIMING COORDINATION

A. Coordinate with the Contract Administrator and The City to determine the date of the shutdown. The Contractor will be given a period of 14 consecutive days during which they will be required to perform all tasks required for the completion of the inspection including restoration of any substrates, surfaces, or ancillary equipment damaged/disturbed as a result of this inspection.

B. Notify Contract Administrator at least 14 days in advance of scheduled inspection start date.

3.2 PRECLEANING FOR INSPECTION

A. Sufficiently dewater and clean the tank to allow for a complete inspection of all the internal surfaces of the tanks. Refer to Section 01 35 13.1.5, Special Project Procedures. If excessive leakage/inflow is present, remove water by use of pumps, dams, and/or other means. Notify Contract Administrator immediately of any leakage.

3.3 INSPECTION

A. Do not begin inspection until completion of the Pre-Inspection Meeting and written permission has been granted by the Contract Administrator.

B. The inspector and/or Contractor shall allow for the accompaniment of the Contract Administrator during the inspection.

C. The scope and depth of the inspection shall be as required to fulfill this specification.

D. The following tests/tasks shall be performed at a minimum:
   1. A condition survey and visual inspection following the recommendations of ACI 201.1R. Identify, describe, measure and locate all descriptions of distress accordingly.
   2. Determine the extent of cement paste loss/concrete degradation.
      a. Visually examine concrete surfaces for the presence of concrete undulations (depressions). Use embedded metals (e.g. access-way hatch frames, attached plates) as an aid in determining the original concrete finish plane.
      b. Examine concrete for the presence of exposed coarse aggregate. Measure depth of cement paste in relationship to the aggregate.
      c. Determine the location and extent of exposed cement paste loss/exposed aggregate throughout the tank
   3. Perform sounding or chain dragging to uncover subsurface voids/defects.
   4. Perform in-situ pH testing using pH papers and/or phenolphthalein indicating solution.
      a. Perform tests on a minimum of 10 locations. Locations above and below the operation waterline shall be tested to assess the effects of the liquid and gaseous attack on concrete during service.
      b. Spray distilled water onto concrete surface test area and allow to reside for approximately 30 to 60 seconds. Touch pH paper to surface and observe color change over a two minute period. Compare color of pH test paper to color chart on pH paper dispenser which has a corresponding numerical pH value. On one end of the scale red color indicates acidic condition (pH 1.0) and on the other end of the scale deep blue indicates alkaline condition (pH 12.0). Perform these tests on undisturbed surfaces. Also perform tests following removal of loose surface materials. Note the pH valve relative to depth. Cease pH testing at depth where a pH of 9.0+ is obtained.
      c. For larger concrete surface areas, spray phenolphthalein indicating solution on scraped, wire brushed or otherwise cleaned surfaces. Record any color change.
   5. Acquire concrete powder samples at various depths to test and establish gradient parameters of the concrete.
      a. Sample a minimum of six locations throughout the train.

b. At each location take samples at a minimum of three different depths.
c. Remove any lose surface materials until hard, sound concrete is reached.
d. Use rotary hammer with 15mm minimum diameter drill bit to acquire concrete powder samples at various depth ranges (e.g. 0mm – 6mm, 6mm – 12mm, etc.). Based on concrete condition, discretion is required to determine the depth of concrete powder samples. It will be necessary to drill several holes at any given depth range in order to acquire sufficient concrete powder for laboratory testing. Consult with test laboratory for required sample size.

6. Acquire a minimum of four concrete core samples, as per ASTM C42, within each tank for laboratory testing. Location of cores to be confirmed with Contract Administrator. Locate core in the field so as to not damage existing reinforcement. Utilize appropriate reinforcement steel scanning equipment. Laboratory testing shall include compressive strength, gradient testing, and petrographic examination. Repair of cores through water retaining walls must be made water tight.
7. Perform laboratory testing of concrete powder samples. Testing is generally performed for pH, sulfate content and chloride ion content as per ASTM C114 and as applicable. The purpose of the laboratory testing is to determine the extent and depth of concrete degradation such that concrete contaminants can be removed as a function of surface preparation and restoration for the proper application of protective coatings/linings.

## 3.4 REPAIR AND RESTORATION

A. Repair and patch concrete that is damaged as a result of required destructive testing. Use fast curing materials as required to complete repairs and allow tank to return to service as scheduled.

B. Restore and/or repair any ancillary equipment or City assets damaged or disturbed as a result of performing the work.

## 3.5 INSPECTION REPORT

A. As a minimum, the inspection report shall include the following:
1. Executive Summary.
2. Inspection Methodology.
3. Field Observations and Condition Survey.
   a. General observations.
   b. Plans, elevations and other drawings showing locations and measurements of concrete distress.
   c. Any other additional information obtained during the inspection.
4. Sampling and Material Testing Results
   a. Sample location data and respective results.
5. Conclusions and Recommendations
   a. Quantified cement loss for the various concrete elements.
   b. Approximate pH gradient as a function of depth in tabular form.
   c. Depth of unsound concrete for the various concrete elements.
   d. Conclusions drawn from other testing that is performed.
   e. Methods of removing unsound concrete for the surface preparation, restoration and application of coating.

f. Review of applicable concrete repair methods called for in the Drawings and specifications.
g. Provide overall opinion on current condition of tanks including life expectancy.
h. Provide opinion on suitability of tanks to be repurposed as specified and shown on Drawings.

6. Appendices
   a. Captioned Photographs including location and orientation information.
   b. Laboratory testing data and results.
   c. Copies of inspections forms, field logs and other raw data obtained during inspection.

## 3.6 MEASUREMENT AND PAYMENT

A. The cost of the work covered in this specification shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective line items in the Proposal Schedule.

END OF SECTION