

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 This section includes the following:
- .1 Horizontal and vertical concrete repairs.
  - .2 Cast-in-place concrete for new structures.
- 1.2 RELATED REQUIREMENTS .1 Section 01 35 29 - Health and Safety Requirements.
- .2 Section 01 45 00 - Testing & Quality Control.
  - .3 Section 01 74 21 - Construction/Demolition Management and Disposal.
  - .4 Section 03 10 00 - Concrete Forming & Accessories.
  - .5 Section 03 20 00 - Concrete Reinforcing.
- 1.3 REFERENCES .1 Canadian Standards Association (CSA).
- .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction.
  - .2 CAN/CSA-A5-03, Portland Cement, in accordance with CAN/CSA A3000-08, Cementitious Materials Compendium.
  - .3 CAN3-A266.1-M78, Air Entraining Admixtures for Concrete.
  - .4 CAN3-A266.2-M78, Chemical Admixtures for Concrete.
  - .5 CAN3-A266.4, Guideline for the use of Admixtures in Concrete.
  - .6 ACI 117-06, Standard Tolerances for Concrete Construction and Materials.
- .2 American Society for Testing and Materials:
- .1 ASTM Standard D6297, 01R07, "Standard Specification for Asphaltic Plug Joints for Bridges"
  - .2 ASTM Standard D260, 86R01, "Standard Specification For Boiled Linseed Oil"
- 1.4 CERTIFICATES .1 Minimum 1 week prior to starting concrete work, submit to Departmental Representative manufacturer's test data and certification by qualified independent inspection and testing laboratory that the following materials will meet

specified requirements:

- .1 Portland Cement.
- .2 Blended hydraulic cement.
- .3 Supplementary cementing materials.
- .4 Grout.
- .5 Admixtures.
- .6 Aggregates.
- .7 Water.

- .2 Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA-A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.
- .3 Provide certification from a qualified independent inspection and testing company that plant, equipment, and materials to be used in concrete comply with requirements of CSA-A23.1/A23.2.

1.5 WASTE  
MANAGEMENT AND  
DISPOSAL

- .1 Separate and recycle waste materials in accordance with the Section 01 74 21 - Waste Management and Disposal.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate a cleaning area for tools to limit water use and runoff.
- .4 Carefully coordinate the specified concrete work with weather conditions.
- .5 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .6 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal. Dispose of all waste in accordance with applicable local, provincial and national regulations.
- .7 Choose least harmful, appropriate cleaning method which will perform adequately.

- 
- 1.6 DESIGN REQUIREMENTS .1 Alternative 1 - performance; in accordance with CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.
- 1.7 SUBMITTALS .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 At least 2 weeks prior to commencing work, inform Departmental Representative of proposed source of aggregates and provide access for sampling.
- .3 As a minimum, submit deep concrete and cast-in-place repair mix information for each mix containing the following information and consistent with the mix design summary in part 2.2.3:
- .1 Cement type.
- .2 Minimum compressive strength at 28 days.
- .3 Exposure classification.
- .4 Slump at time of discharge.
- .5 Nominal size of coarse aggregate.
- .6 Air content (%).
- .7 Supplementary cementing materials type.
- .8 Percentage of supplementary cementing materials by weight of total cementing materials.
- .9 Cement content (kg/m<sup>3</sup>).
- .10 Water-to-cement ratio.
- .11 Proposed admixtures.
- .4 The plant from which the ready mix concrete is supplied shall be certified in accordance with the requirements for certification as published by the Atlantic Provinces Ready Mix Concrete Association or equivalent. A copy of the certification of conformance shall be provided to the Departmental Representative prior to the start of delivery under the proposed contract.
- .5 Provide manufacturer's specifications, technical and performance data on two-component concrete repair mortar to be used for shallow concrete repair applications.
- .6 Provide manufacturer's specifications, technical and performance data on the epoxy based crack sealant to be used for crack repairs.

- 
- 1.8 QUALITY ASSURANCE
- .1 Quality Assurance: in accordance with Section 01 45 00 - Testing and Quality Control.
  - .2 Provide Departmental Representative, minimum 2 weeks prior to starting concrete work, valid and recognized certificate from plant delivering concrete.
    - .1 When plant does not hold valid certification, provide test data and certification by qualified independent inspection and testing laboratory that materials used in concrete mixture will meet specified requirements.
  - .3 Minimum 1 week prior to starting concrete work, provide proposed quality control procedures for review by Departmental Representative on following items:
    - .1 Falsework erection.
    - .2 Hot weather concrete.
    - .3 Cold weather concrete.
    - .4 Curing.
    - .5 Finishes.
    - .6 Formwork removal.
    - .7 Joints.
  - .4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
  - .5 A job meeting shall be held prior to the repair concrete placement to discuss all aspects of the concrete work including production, supply, delivery, placing, curing and any other related items. This meeting is to be called by the Departmental Representative, the Contractor and all others deemed necessary by the Departmental Representative shall be in attendance.
- 
- 1.9 DELIVERY, STORAGE AND HANDLING
- .1 Concrete hauling time: maximum allowable time for concrete to be delivered to site of Work and discharged within 120 minutes maximum after batching.
    - .1 Modifications to maximum time limit must be agreed to by Departmental Representative and concrete producer as described in CSA A23.1/A23.2.
    - .2 Deviations to be submitted for review by

Departmental Representative.

- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

1.10 RESPONSIBILITY

- .1 The Contractor shall indemnify and save harmless Canada with regard to claims arising from damages or injury.
- .2 The Contractor shall be responsible for the placement and maintenance of barricades.

1.11 TEMPORARY SUPPORTS

- .1 Depending on the contractor's method and sequencing of demolition work related to the repairs, the stability of the structure could be temporarily compromised during construction. As such, the contractor shall provide temporary bracing, supports and shoring as necessary to stabilize the structure throughout the course of construction. The design and implementation of these temporary supports shall be submitted to the Departmental Representative under seal of a Professional Engineer licensed to practice in the Province of Newfoundland and Labrador.
- .2 Contractor will assume full responsibility for the integrity of the structures during the work. Contractor is to provide adequate temporary bracing, shores and uplifts restraint to maintain structural safety, plumb and true alignment until completion of work.
- .3 Refer to drawings for any specific sequencing requirements.
- .4 All scaffolding, temporary working platform supports and structures shall be submitted to the Departmental Representative under seal of a Professional Engineering licensed to practice in the Province of Newfoundland and Labrador.
- .5 All temporary housing and enclosures, including these used for cold weather purposes, shall be submitted to the Departmental Representative under seal of a professional engineer licensed to practice in the province of Newfoundland and Labrador.

1.12 MEASUREMENT FOR .1  
PAYMENT

Concrete Repairs: Measure repairs to any deteriorated concrete surface and/or edge on the existing fishway structure. Actual areas and locations of deteriorated concrete to be repaired shall be confirmed onsite with the Departmental Representative. At no time shall the repair quantity stipulated in the unit price table be exceeded without prior approvals from the Departmental Representative.

- .1 Surface Repairs: Measurement for concrete surface repairs shall be in square metres (m<sup>2</sup>) of repaired surface area. The repair area shall be adjusted based on the depth of concrete repair. For repair areas with a depth up to 150 mm, the repair area will not be adjusted. For repair areas with a depth that exceeds 150 mm, the area for surface repairs shall be increased by 50% for each additional 150 mm depth or portion thereof.
- .2 Edge Repairs: Measurement for concrete edge repairs shall be in linear metres (lm) of repaired surface length. The repair length shall be adjusted based on the depth of concrete repair. For repair lengths with a depth up to 150 mm, the repair area will not be adjusted. For repair lengths with a depth that exceeds 150 mm, the length for edge repairs shall be increased by 50% for each additional 150 mm depth or portion thereof.
- .3 Measurement shall be considered to include furnishing of all materials, aggregates, cement, supplementary cementing materials, reinforcing steel, tools, equipment, bonding agents, falsework, forms, bracing, layout, curing, surface finishing and all other items required to complete the work, as specified.
- .4 No repair area shall be paid for more than once.
- .5 All demolition and removal including cleaning and preparatory work shall be considered incidental to this unit of measure.
- .7 All requirements for hot and cold weather concreting to be considered incidental to this unit of measure.

.3 Cast-in-Place Concrete (New Structures):

- .1 As specified including all plant material, labour and equipment will be measured in cubic metres (m<sup>3</sup>) of concrete supplied and placed in the work. Included incidental to this unit price is all reinforcing steel, anchor bolts, dowels, rock anchors, grout, bonding agent, galvanized steel sill plate, formwork and related accessories.  
New concrete structures shall be installed on a competent rock surface as approved by the Departmental Representative. Include incidental to the measurement for payment all surface preparation including the removal of loose rock,

- fragmented rock, and intentional surface roughening (including that of hardened concrete) as approved by Departmental Representative.
- .2 No separate measurement will be made for any other ingredient or feature of the concrete work including scheduling, cold weather placement, underwater curing, additives, cement, aggregates, finishing, plant or labour. All such items will be considered incidental to the work, and costs included in the unit price bid for Cast-in-Place Concrete (New Structure).
  - .4 No separate measurement will be made for preparation of rock or existing concrete to receive concrete.
  - .5 No separate measurement for payment shall be made for diving services required to complete any aspects of this work. Include costs for diving services in the lump portion of the work on the bid and acceptance form.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- .1 Cement
  - .1 All cementing materials shall be in accordance with CAN/CSA A3000.
  - .2 Cement for all concrete shall be Portland cement Type GU, a portion of which may be replaced by fly ash up to 25% by mass of the total cementing material.
- .2 Aggregates
  - .1 The course of the aggregate will be determined by the Contractor but all aggregate shall meet the requirements of CSA Standard CAN/CSA-A23.1-M. The maximum petrographic number will be 135.
  - .2 Concrete aggregate shall consist of natural sands and gravels, crushed rock or other inert materials having clean, uncoated grains of strong and durable minerals.
  - .3 Fine and coarse aggregate shall be stored in separate stock piles sufficiently removed from each other to prevent the materials at the edges of the piles from becoming intermixed.
  - .4 Aggregate shall be free from alkali, organic matter or other deleterious substances and shall not contain soft, friable, thin, laky, elongated or laminated particles totaling more than 3% nor contain shale in excess of 1.5%, nor silt and crusher dust finer than

August 2016

- 75µm sieve size, in excess of 2%. The percentages shall be based on the weight of the combined aggregate as used in the concrete. When all three groups of these deleterious materials are present, the combined amounts shall not exceed 5% by weight of the combined aggregate.
- .5 The maximum size of stone to be used for the different thickness of concrete shall be 20 mm unless otherwise ordered by the Departmental Representative. In no case shall the maximum size of stone used be greater than either 2/3 the clear distance between the reinforcement or 2/3 the clear distance between the exterior bars and the face of the structure except for girders where the latter criteria shall be 0.8 times the clear distance between the exterior bars and the face of the structure.
- .6 Stock piles of approved fine and coarse aggregate, in amounts of one quarter to one half of that required for the job, shall be placed on the site of the work at least one month previous to concrete placing operations. The stockpiles shall be protected by tarpaulins or plastic sheeting against formations of ice and accumulation of snow.
- .7 The Contractor shall provide with the concrete mix design relevant test data for all aggregate materials indicating conformance to the requirements of CSA-A23.1 and this specification. The sources and test results of all aggregate materials shall be clearly identified. The aggregate tests shall be conducted by a testing laboratory CCIL or CSA Certified in accordance with CSA Standard A-283-06 or latest edition. Test results are only considered valid for up to two years in advance of the date of the project mix design submission. The test data required but not be limited to shall include:
- Sieve Analysis of Fine and Coarse aggregate CSA-A23.2-2A.
  - Amount of Material Finer than 75 µm in Aggregate CSA-A23.2-5A.
  - Bulk Relative Density and Absorption of Fine and Coarse Aggregate (SSD basis) CSA-A23.2-6A

- Fineness Modulus of Fine Aggregate CSA-A23.2-2A.
- Clay Lumps and Light Weight Pieces CSA-A23.2-3A.
- Test for Organic Impurities in Fine Aggregate CSA-A23.2-7A.
- Flat and Elongated Particles in Coarse Aggregates CSA-A23.2-13A.
- Petrographic Analysis of Coarse Aggregate CSA-A23.2-15A.
- Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles machine CSA-A23.2-16A.
- Micro-Deval test for Coarse and Fine Aggregate CSA-A23.2-23A and 29A.
- Soundness of Coarse and Fine Aggregate by Use of Magnesium Sulphate CSA-A23.2-9A.
- Test for Detection of Alkali-Aggregate Reactivity (AAR) on Coarse and Fine Aggregate CSAA23.2-25A.
- Unconfined Freeze Thaw Test CSA-A23.2-24A.

.3 Water

- .1 All water shall be clear and free from injurious substances and shall be potable.
- .2 All water used for curing shall be clean and free of any material which would cause staining or discoloration of the concrete. The contractor shall not use water from shallow, stagnant or marshy sources.

.4 Air Entraining Agent

- .1 All concrete shall be air entrained with the air entraining agent conforming to CSA Standard CAN3-A266.1-M.

.5 Admixtures

- .1 Any other admixture must be approved by the Departmental Representative and shall conform to CSA Standard CAN3-A266.2-M.
- .2 Admixtures shall not contain more than 1% chloride ion content by weight.
- .3 Accelerating Admixtures - Unless otherwise approved by the Departmental Representative, all concrete shall be placed in dry conditions. However, the later stages of curing for the new concrete sill may have to occur in wet or fully submerged conditions depending on dewatering limitations.

August 2016

Therefore, the mix design shall address the use of accelerating admixtures in order to increase the rate of early strength development and reduce the required time for curing. The use of accelerating admixtures shall be included on the shop drawings submission.

- .6 Reinforcement
  - .1 Reinforcement shall conform to Section 03 20 00 - Concrete Reinforcing.
- .7 Form work and Falsework
  - .1 Form work and falsework shall conform to Section 03 10 00 - Concrete Forming and Accessories.
- .8 Burlap
  - .1 Burlap shall conform to AASHTO M182 "Specification for Burlap Cloth made from Jute or Kenaf".
- .9 Filter Fabric
  - .1 Filter fabric shall be a non-woven geotextile with a minimum mass of 340 gm/m<sup>2</sup> and a minimum thickness of 3.3 mm; all properties tested in accordance with CGSB CAN 24.2-M77 test methods.
  - .2 Filter fabric or non-woven geotextile may be used on flat horizontal surfaces but not on vertical surfaces. Vertical surfaces, i.e. abutments shall be cured using saturated burlap only.
- .10 Moisture Barrier
  - .1 Moisture barrier shall conform to ASTM C171, "Sheeting Materials for Curing Concrete".
- .11 Membrane Curing Compounds
  - .1 Membrane curing compounds shall meet the requirements of ASTM C309, and shall only be used with the approval of the Departmental Representative.
- .12 Obtain approval from Departmental Representative prior to use of super plasticizing admixture.
- .13 Unless otherwise indicated, concrete shall be normal and shall have a unit weight of 2350 kg/m<sup>3</sup>.
- .14 Concrete retarder; to ASTM C494/C494M-10. Do not

allow moisture of any kind to come in contact with the retarder film.

- .15 Bonding Agent: Bonding agent to be weld-crete or approved equal, or as recommended by manufacturer for pre-manufactured products.
- .16 Two-Component Concrete Repair Mortar:
  - .1 Horizontal Repairs
    - .1 Two-component, polymer modified mortar with corrosion inhibitor, fast setting, high abrasion resistance, high early strength, structural repair grade.
    - .2 Suitable for single lift repair thickness up to at least 25 mm deep. Multiple lifts to be applied as necessary to achieve the full repair depth in strict accordance with the manufacturer's recommendations.
    - .3 Apply suitable bonding agent if recommended by manufacturer. Bonding agent shall be compatible with mortar, applicable to the project application, and approved by the Departmental Representative.
    - .4 Use on grade, above, and below grade on horizontal concrete surfaces.
    - .5 Application Time 23°C Approx. 30 min after mixing the mortar.
    - .6 Finishing Time 23°C Approx. 50 mins to 1 hr 15 min after placing the mortar.
    - .7 Properties at 23°C and 50% R.H.
      - .1 Density ASTM C185, 2200 kg/m<sup>3</sup>.
      - .2 Compressive Strength ASTM C109:
        - 24 hours 18 MPa
        - 7 days 37 MPa
        - 28 days 50 MPa
      - .3 Modulus of Elasticity ASTM C469:
        - 7 days 23 GPa
        - 28 days 26 GPa
      - .4 Tensile Splitting Strength ASTM C496:
        - 21 days 5.5 MPa
      - .5 Bond Strength ASTM C882
        - 24 hrs 9 MPa
        - 28 days 19 MPa
      - .6 Bond Strength CAN A23.2-6B.
        - 28 days - Greater than concrete.
      - .7 Rapid Chloride Permeability

AASHTO T277

14 days 375 Coulombs

- .8 Standard of acceptance: SikaTop 122 Plus

.2 Vertical and Overhead Repairs

- .1 Two-component, polymer modified mortar with corrosion inhibitor, fast setting, high abrasion resistance, high early strength, structural repair grade.

- .2 Suitable for single lift repair thickness repairs up to at least 25 mm deep. Multiple lifts to be applied as necessary to achieve the full repair depth in strict accordance with the manufacturer's recommendation.

- .3 Apply suitable bonding agent if recommended by manufacturer. Bonding agent shall be compatible with mortar, applicable to the project application and approved by the Departmental Representative.

- .4 Use on grade, above, and below grade on vertical and overhead concrete surfaces.

- .5 Application Time at 23°C Approx. 15 min after mixing the mortar.

- .6 Finishing Time at 23°C Approx. 30-60 min after placing the mortar.

- .7 Properties at 23°C and 50% R.H.

- .1 Density ASTM C185, 2200 kg/m<sup>3</sup>.

- .2 Compressive Strength ASTM C109:

24 hours 20 MPa

7 days 37 MPa

28 days 50 MPa

- .3 Modulus of Elasticity ASTM C469:

7 days 17 GPa

28 days 26 GPa

- .4 Tensile Splitting Strength ASTM C496:

21 days 5 MPa

- .5 Bond Strength ASTM C882

24 hrs 7 MPa

28 days 17 MPa

- .6 Bond Strength CAN A23.2-6B.

28 days - Greater than concrete.

- .7 Rapid Chloride Permeability

AASHTO T277

14 days 270 Coulombs

- .8 Standard of acceptance: SikaTop 123 Plus. Refer to Section 01 16 10 - Material Supplied by Canada.

- 2.2 CONCRETE MIXES (CAST-IN-PLACE CONCRETE FOR NEW STRUCTURES)
- .1 Concrete shall be mixed and proportioned in accordance to CSA A23.1, Clause 4.3.
- .2 Concrete shall be proportioned to comply with Alternative 1, Table 2 in CSA A23.1 and following requirements:
- .1 Cement: Type GU, Portland Cement.
- .2 Minimum compressive strength of all concrete to be 40 MPa at 28 days.
- .3 Class `F1` exposure.
- .4 Nominal size of coarse aggregate 20 mm.
- .5 Slump range at point of discharge 50 mm to 100 mm.
- .6 Air Content 5-8 percent.
- .7 Density of air-dry concrete will be in range of 2240 to 2400 kg/m<sup>3</sup>.
- .8 Minimum cement content: 385 kg/m<sup>3</sup>.
- .9 High range water reducing agents (superplasticizers) may be used at the Contractor's request, if so indicated when the mix design is submitted. The Contractor must demonstrate competence and experience in their use and specific approval must be obtained. The Contractor shall state his method of concrete placement when submitting his concrete mix design.
- .10 If superplasticizers are used, the maximum concrete slump in a superplasticized condition shall be limited to 230 mm. The mix design shall state the design slump before and after the addition of superplasticizers along with the appropriate tolerances. Note that the slump in the above may not be applicable when using superplasticizers.
- .11 Accelerating Admixtures: unless otherwise approved by the Departmental Representative, all concrete shall be placed in dry conditions. However, the later stages of curing for the new concrete sill in pool #6 may occur in wet or fully submerged conditions, depending on dewatering limitations. Therefore, the mix design shall address the use of accelerating admixtures in order to increase the rate of early strength development and reduce the required time for curing. The details pertaining to the use of accelerating admixtures shall be

included on the shop drawings submission.

- .3 When the Contractor wishes to purchase concrete from a ready mix concrete supplier, submit a letter from the supplier certifying the following:

.1 That his plant and equipment is certified and all materials to be used in the concrete comply with the requirements of CSA Standard CSA A23.1.

.2 That the mix proportions selected will produce concrete of the specified quality and yield. Indicate mix proportions and sources of all materials.

.3 That the strengths will comply with the strengths specified herein.

- .4 When the Contractor wishes to mix concrete on site, he shall identify the source of aggregates and submit samples of fine and coarse aggregates to a testing laboratory for testing and trial mixes in order to determine a suitable mix design. The testing laboratory, at Contractor's cost, will test the trial mix for slump, air content, density and strength. The results of these tests will be submitted to the Departmental Representative to be reviewed for compliance with the specification. This review must be completed before permission to place concrete is given.

.1 The sand, gravel, water and air entraining agent should be mixed prior to the addition of cement and water reducer.

- .5 Weigh aggregates, cement, water and admixture when batching. No alternative methods of measuring will be permitted.
- .6 Do not use calcium chloride.

## 2.3 EQUIPMENT

- .1 The Contractor shall supply the Departmental Representative before commencement of the project with adequate details of all equipment to be used. The intention is not to limit the Contractor's operation but to ensure adequate planning is undertaken.
- .2 The Contractor shall maintain all equipment used for handling, mixing, transporting, depositing, compacting, curing and finishing the concrete in

a clean condition and in proper working order.

- .3 Pumping equipment may be utilized by the Contractor. Details of the pumping equipment and operation must be approved by the Departmental Representative. The Contractor shall submit to the Departmental Representative, manufacturer's specifications detailing pumping capacity and pressure at the required elevations. Aluminum pipelines shall not be used. The Contractor shall be prepared in the event of a breakdown in pumping operations. These emergency preparations shall be discussed with and approved by the Departmental Representative prior to the commencement of concrete placement utilizing pumping equipment.
- .4 Compaction equipment shall be capable of giving dense concrete in accordance with specification requirements. Internal vibrators shall have a frequency of 160 Hz.
- .5 An approved finisher shall be used to strike off and finish concrete as per specifications.
- .6 Batching equipment shall be as defined in 2.2 of this specification.
- .7 The equipment required for heating materials for Cold Weather Concreting shall be of adequate capacity and be approved by the Departmental Representative; it shall be available, installed and tested ready for use before it is proposed to place concrete. Heating equipment shall be ready for use between September 1 and April 30 when so required by the Departmental Representative. Alternative methods of keeping concrete temperatures at acceptable levels may be approved. Where the heating equipment is to be used for heating the housing as well as the materials at the same time, the term adequate capacity means that the equipment shall have adequate capacity to heat both materials and housing simultaneously to the required temperature.
- .8 Boilers used for heating materials or housing shall meet the inspection requirements and operating conditions laid down by Federal and Provincial Acts/Regulations.

August 2016

- .9     Blasting equipment to be capable of removing all direct, oil and other foreign material as well as laitance from surface of concrete, and removing rust from exposed reinforcement.
- .10    Vacuum or compressed air equipment to be capable of removing all dust or loose material from concrete surface after sandblasting. In case of compressed air it is to be free from oil.
- .11    Power-Driven hand tools to be permitted for removal of concrete with following restrictions:
  - .1     Use "Jack Hammers" not heavier than nominal 13 kg class.
  - .2     "Jack Hammers" or mechanical chipping tools to be operated at an angle less than 45 degrees measured from the vertical.
  - .3     Use "chipping hammers" not heavier than nominal 6.8 kg class to remove concrete from beneath any reinforcing steel or other embedments.
  - .4     Use other hand tools such as hammers and chisels for removal of final particles of unsound concrete or to achieve required depth.
- .12    Other equipment not specifically stated above is subject to approval by the Departmental Representative.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- .1     Obtain Departmental Representative's approval before placing concrete. Provide 24 hours minimum notice prior to placing of concrete.
- .2     Place, consolidate, finish, cure and protect concrete to CAN/CSA-A23.1 except where specified otherwise.
- .3     Pumping of concrete is permitted only after approval of equipment and mix.
- .4     Secure in position reinforcing steel, embedded parts, etc. prior to placing concrete and ensure these are not disturbed during concrete placement.
- .5     Secure in position anchor bolts during placement

of concrete. Place anchor bolts with templates.

- .6 Prior to placing of concrete obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .7 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, and air temperature and test samples taken.
- .8 Do not place load upon new concrete until authorized by Departmental Representative.
- .9 During concreting operations:
  - .1 Location of construction/cold joints must be pre-approved by the Departmental Representative prior to construction.
  - .2 Ensure concrete delivery and handling facilities placing with minimum of re-handling, and without damage to existing structure or work.
- .10 Ensure that formwork is thoroughly clean before placing.
- .11 Remove all rust and chlorides from existing steel and reinforcement designated to remain to SSPC-SP6, Commercial Blast Clean prior to application of bonding agent/primer.
- .12 Place concrete in dry conditions, unless otherwise approved by the Departmental Representative.
- .13 Roughen surface of parent concrete to full amplitude of at least 5 mm and remove all loose material prior to application of bonding agent/primer.
- .14 Apply bonding agent/primer to prepared surfaces of parent concrete and coat all exposed rebar surfaces. Apply immediately prior to placement of repair concrete.
- .15 Do not allow bonding agent/primer to dry prior to placing repair concrete.
- .16 Where form fixing requirements do not allow placement of repair concrete within sufficient time before bonding agent/primer is dry, apply

repair concrete directly to parent concrete prepared as follows:

- .1 Parent concrete shall be kept continuously wet for a period of 24 hours prior to repair. Prior to placing repair concrete, pat surface of parent concrete dry and remove free water.
- .17 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .18 Protect previous work from staining.
- .19 Bond fresh concrete to hardened concrete to CAN/CSA A23.1 or with an approved pre-manufactured bonding agent.
- .20 Do not permit vertical free fall of concrete mix to exceed 1500 mm.
- .21 Concrete trucks, highway traffic or any other vehicles or heavy load as defined by Departmental Representative are not permitted to drive on reinforcing mats.
- .22 Do cast-in-place concrete work in accordance with CSA-A23.1/A23.2.
- .23 Construction Joints:
  - .1 Construction joint locations shall be approved by the Departmental Representative wherever they are not specifically designated on the drawings.
  - .2 Sections of concrete repair to be patched shall be placed in one continuous operation.
  - .3 The Contractor shall attach the appropriate horizontal and/or vertical strips to the face(s) of the formwork where all construction joints are planned or occur for reasons beyond the Contractor's control. The concrete shall be worked such that the finished appearance will resemble narrow, neat and straight horizontal and/or vertical line(s) at all construction and cold joints. Forms shall be kept tight throughout the entire concrete placing operation.
  - .4 Prior to butting the new concrete against previously hardened concrete the joint face shall be cleaned of all debris and dirt.
  - .5 In addition, the surface film of laitance and mortar shall be removed from the joint

- 
- face to present a clean sound concrete face that has the aggregate particles exposed.
- .24 Mark repair areas:
- .1 Chalk used for chalk-lining saw cuts shall not be red or any colour with a dye that would stain the concrete. Use white or light grey chalk only.
- .2 Repair areas to be determined on site with Departmental Representative.
- .25 Saw cut around areas of existing concrete to be removed:
- .1 Cut the edges of the area to be removed with a perpendicular saw cut. Overhead areas excluded.
- .2 Do not cut through reinforcing bars.
- .3 For areas where saw cutting is not possible, use approved chipping tools to remove concrete. Ensure that edges of repair area are cut perpendicular to the surface.
- .4 Mark the repair area prior to cutting. Avoid sharp acute angles and re-entrant corners.
- .5 Slightly roughen saw cut face with a needle gun prior to placement of repair concrete.
- .6 Finish the concrete in such a way as no joint is visible between parent concrete and new repair concrete. Overlap the new concrete over parent concrete to avoid visible joint.
- .7 If additional areas are found after concrete removal, the new perimeter shall be saw-cut as per procedure above.
- .26 Remove concrete in a manner so as to prevent damage to adjacent concrete, other components and utilities that are to remain in place. Reinforcing steel, inserts, structural steel and other components that are to remain in place shall not be damaged or loosened.
- .27 Hammers shall not come in contact with reinforcing bars, which may cause debonding of bars in adjacent concrete areas not being repaired.
- .28 Concrete removal shall not be permitted within 1 m of newly placed concrete for a period of 72 hours.
- .29 Where area of concrete removed with exposed reinforcing to remain exceeds 1 m<sup>2</sup>, retie

reinforcing steel at every second intersection point and secure in place prior to placement of repair concrete.

- .30 Concrete debris shall be removed completely from the site. Dispose of debris in accordance with applicable environmental regulations and in such a manner as to prevent any unsightly appearance from the project site.
- .31 Waterstops:
  - .1 Install new waterstops where indicated to provide continuous water seal. Do not distort or pierce waterstop in such a way as to hamper performance. Do not displace reinforcement when installing waterstops. Use equipment to manufacturer's requirements. Secure waterstops rigidly in place.
- .32 Anchor Bolts:
  - .1 Install anchor bolts, as detailed on the structural drawings, complete with nuts, washers and bolts.
  - .2 Set anchor bolts to template under supervision of appropriate trade prior to placing concrete.
- .33 Apply repair concrete to prepared surfaces immediately after placement of bonding agent/primer.
- .34 Concrete shall not be placed on or against any surface (including rebar) that is at a temperature below 5°C.
- .35 Concrete at time of deposit shall be between 10°C and 30°C, unless noted or approved otherwise.
- .36 Pour concrete continuously between predetermined construction joints. Refer to part 3.1.23 of this specification section.
- .37 Carry out winter concreting in strict accordance with CSA-A23.1/A23.2 and Part 3.14 - Cold Weather Concreting in this section.
- .38 The Contractor is required to supply all cement, bonding agents, and other specialty items to be incorporated in the work.

August 2016

- 
- .39 The supply and use of all specialty items shall conform to manufacturer's instructions and recommendations, applicable governing standards and shall be subject to approval by the Departmental Representative. The Contractor shall also supply the Departmental Representative with copies of the relevant specifications for the above items.
  - .40 Any reinforcing steel, which in the opinion of the Departmental Representative, has been damaged due to negligence of the Contractor, shall not be paid for.
  - .41 Concrete, during and immediately after depositing, shall be thoroughly compacted by mechanical vibration.
  - .42 The Contractor shall provide a sufficient number of vibrators and they shall be manipulated so as to thoroughly work the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms.
  - .43 Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, until the air bubbles stop breaking on the surface. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.
  - .44 Vibration shall not be used to make concrete flow into place. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which vibration is visible.
  - .45 When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete.
  - .46 During wet weather, concrete must not be placed unless suitable means, approved by the Departmental Representative, have been provided to prevent washing of freshly deposited concrete

or marring of the exposed surface.

.47 Evaporation Retardent:

- .1 Immediately after the straight edge requirements have been met for the concrete and the finish applied, the fresh concrete shall be coated with an evaporation retardant, to approval of the Departmental Representative, to preclude rapid evaporation of the bleed water. When all bleed water is gone, the concrete shall be cured as described herein.

3.2 CONCRETE REPAIRS .1

Repairs to any deteriorated concrete surface and/or edge on the existing fishway structure which requires a repair shall be completed accordingly.

.2 Below are some general preparation and application guidelines for completing this repair. In all cases the manufacturer's instructions for the repair mortar shall govern.

- .1 Prepare surface or edge for repair by saw cutting repair boundaries (no feather edges), chipping, high pressure water blasting or other appropriate mechanical means with equipment approved by the Departmental Representative down to sound concrete. Obtain substrate aggregate facture with minimum surface profile of +/- 5 mm. Damper surface to be repaired with clean water. Substrate should be saturated surface with no standing water during application.

- .2 A repair product or products for this application shall be an approved polymer modified, structural grade mortar, capable of repairing horizontal, vertical and overhead concrete, concrete surfaces, and achieve a minimum 28-day compressive strength of 50 mPa. In addition, the product shall be suitable for this application and have superior abrasion resistance capabilities.

- .3 At time of application, repair area shall be damp (saturated surface dry) but free from standing water or glistening water films. Apply a recommended thickness of scrub coat of the mixed mortar or an approve bonding agent compatible with the repair mortar, into the substrate, filling all

August 2016

- pores, voids and edges and completely covering the repair or resurfacing area.
- .4 Onto the fresh scrub coat, force the mortar against the edge of the repair area or onto the resurfacing area, working towards the centre and observing minimum and maximum layer thicknesses. If the repair or resurfacing requires several lifts (layers), apply the mortar, leaving a rough profile, and then score the surface immediately in a cross-hatch pattern to a depth of approximately 6 mm to provide a key. Allow the layer to achieve initial set and then apply subsequent layers as soon as the previous lift will support it without being displaced.
- .5 Allow the completed repair to set to desired stiffness then finish in accordance with part 3.8 of this section. In areas of the fishway interior, extreme attention shall be given to insure these edges and surfaces are smooth and non-abrasive. Avoid over dampening the face of the mortar during finishing and avoid over-finishing the material.
- .6 All workmanship related to surface preparation, application, finishing and curing shall be in strict accordance with the manufacturers recommendations and approved by the Departmental Representative.

3.3 CAST-IN-PLACE  
CONCRETE FOR NEW  
STRUCTURES

- .1 General
- .1 The work will entail the following.
- .1 New concrete sill.
- .2 New concrete floor in pool #6.
- .2 Removal
- .1 If concrete is to be removed from an adjoining structure it shall be done by jackhammer, the maximum hammer mass permitted is 13 kg. The Contractor shall take care not to damage any existing steel that is designated to remain.
- .3 Surface Preparation
- .1 The work shall be performed as per the drawings and under the direction of the Departmental Representative. However, no concrete shall be placed until the prepared surface to be restored is inspected and approval in writing

August 2016

- is given by the Departmental Representative.
- .2 For a 24 hour period, the substrate shall be dampened followed by a rich mixture of cement and water. Excess and ponded water shall be removed before the application of the cement and water mixture.
  - .3 Roughen surface of parent concrete to full amplitude of at least 5 mm and remove all loose material prior to application of bonding agent/primer.
  - .4 Supply and Placement of Concrete
    - .1 All aspects of concrete supply and placement are subject to approval by the Departmental Representative. High range water reducing agents (superplasticizers) may be used at the Contractor's require if so indicated when the mix design is submitted. The Contractor must demonstrate competence and experience in their use and specific approval must be obtained.
    - .2 The concrete mix design shall be in accordance with Part 2.2 "Mixes, Cast-in-Place (new structures), in this specification section.
    - .3 Maximum aggregate size shall be 20 mm, and the aggregate must be sound with a Petrographic Number not greater than 135 and an abrasion loss not greater than 35%.
    - .4 Accelerating Admixtures: Unless otherwise approved by the Departmental Representative, all concrete shall be placed in dry conditions. However, the later stages of curing for the new concrete sill in pool #6 may occur in wet or fully submerged conditions, depending on dewatering limitations. Therefore, the mix design shall address the use of accelerating admixtures in order to increase the rate of early strength development and reduce the required time for curing. The use of accelerating admixtures shall be included on the shop drawings submission.
  - .5 Curing
    - .1 Immediately after the straight edge requirements have been met with fresh concrete shall be shielded from solar radiation and wind to preclude rapid evaporation of the bleed water. All aspects of curing shall be in accordance with Part 3.10 of this specification section.
  - .6 Finishing

- .1 To be in accordance with Part 3.8 of this specification section.

### 3.4 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated and paid by Departmental Representative in accordance with CSA A23.1/A23.2.
- .2 For compressive strength testing of concrete a minimum of 3 cylinders and 2 field cured cylinders are required for:
- .1 Each day's pour.
  - .2 Each type of grade of concrete.
  - .3 Each change of supplier.
  - .4 Each 40 cubic meter or fraction thereof.
  - .5 Additional test specimen shall be taken whenever requested by the Departmental Representative to verify the concrete quality.
  - .6 Additional test specimen shall be taken during cold weather concreting.
- .3 Cure cylinders on job site under same conditions as concrete which they represent.
- .4 Non-Destructive Methods for Testing Concrete shall be in accordance to CSA A23.1/A23.2.
- .5 Inspection and testing by testing laboratory will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

### 3.5 CONCRETE COVER OVER REINFORCEMENT

- .1 Ensure reinforcing steel is placed to specified tolerances.
- .2 Concrete cover around reinforcing steel shall be as follows unless noted or approved otherwise:
- .1  $75 \pm 12$ .
  - .2 Other conditions as noted on drawings.
- .3 Provide continuous supervision during the placement of concrete to ensure that the reinforcing steel is maintained in its correct position.
- .4 Cover requirements may be subject to change by

August 2016

Departmental Representative in areas where existing reinforcement is to remain in place and new reinforcement is to tie into existing.

3.6 FINISHING

- .1 Finish concrete in accordance with CSA-A23.1/A23.2.
- .2 All concrete surfaces that will be visible on completion of the work shall conform to surface finish Class 2.
- .3 The Contractor shall take special care during the planning, forming, concrete placing, curing and stripping phases to ensure defect-free surfaces. Should remedial measures be required, they shall be carried out by personnel expert in this aspect of concrete work. The surfaces shall be uniform in colour and texture when viewed from a distance of 15 m and shall be attained as follows.
- .4 Class 2 Rubbed Finish
  - .1 Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges and other defects shall be cut back to sound concrete and thoroughly cleaned. No feather edging is permissible. If reinforcing steel is exposed, concrete shall be cut back for at least 50 mm around the reinforcement.
  - .2 After having been kept saturated with water for a period of not less than three (3) hours, the cavities shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured as specified under this section. No mortar shall be placed when the air temperature is forecasted to fall below 5°C within 24 hours. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges. The resulting surfaces shall be true and uniform.

August 2016

- .3 After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. However, before starting this work the concrete shall be kept thoroughly saturated with water for a minimum period of three (3) hours but sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing of rod holes and defects to thoroughly set. Surfaces to the finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face.
- .4 The mortar shall be composed of extra cement and fine sand mixed in proportions such as to match existing concrete verified by a test patch. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place at this time.
- .5 After all concrete above the surface being treated has been case, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform colour. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

3.7 CAULKING OF JOINTS

- .1 Caulking shall be applied to all control and expansion joint locations.
- .2 The caulking or sealant and the substrate material must have a temperature greater than 5°C. Under no circumstances should sealant be applied to any surface which contains moisture, condensation or frost. Joint surfaces are to be clean, dry and free of foreign matter before application of primer and sealant.
- .3 The work shall be performed by an approved caulking applicator. Otherwise, the contractor must designate a person for the caulking operation and that person should receive training acceptance to the Manufacturer and Engineer.

- .4 The Contractor shall supply a written guarantee of all workmanship and materials for a period of two (2) years following the date of final completion.
- .5 Sealant shall be a three component Type 1-Dymeric (epoxidized polyurethane terpolymer) sealant as approved by the Departmental Representative, selected to most closely match the concrete colour. Primers are to be those specified by the sealant manufacturer. Joint backing shall be a closed-cell nongaseous backer rod, approved by the Departmental Representative.
- .6 All work shall be in strict accordance with the Manufacturer's recommendations.

### 3.8 CURING

- .1 General
  - .1 Cure concrete in accordance with CSA-A32.1/A23.2.
- .2 Moist Curing
  - .1 Concrete shall be continuously kept in a damp moist condition for at least seven (7) days after placing and the temperature of the concrete shall not be less than 10°C, during this period. If ambient temperatures are at or anticipated to be:
    - (a) Greater than 25°C, then the provision of Part 3.13, "Hot Weather Concreting", shall be followed
    - (b) Less than 5°C, then the provision of Part 3.14, "Cold Weather Concreting", shall be followed.
  - .2 Curing shall be applied to all surfaces.
  - .3 Curing shall take place as soon as possible after the finishing operation without damaging the surface.
  - .4 The entire surface of the newly place concrete shall be covered by whatever curing medium is applicable to local condition and approved by the Departmental Representative.
- .5 Plastic Shrinkage
  - .1 If shrinkage cracks occur the Contractor shall grout any cracks and repair by an approved method at his own expense.
  - .2 All methods and materials employed in concrete curing must be approved by the Departmental Representative.

3.9 HOT WEATHER  
CONCRETING

- .1 When the air temperature is at 25°C or greater or is expected to rise to this limit, according to meteorological forecasts, then special measures shall be taken by the Contractor to protect the concrete. Surface moisture evaporation must not exceed 0.75kg/m<sup>2</sup>/hr. Concrete placed in the forms shall be maintained at or below 27°C and the Contractor shall obtain from the Departmental Representative approval for his measure to ensure this. Curing shall be by moisture.

3.10 COLD WEATHER  
CONCRETING

- .1 When the air temperature is at or below +5°C or when, according to meteorological forecasts, it is likely to fall below this limit within the next 24 hours, then the Contractor shall take special precautions to protect the concrete placed. The Contractor shall obtain approval from the Departmental Representative for this method of protection.
- .2 The following table shall apply for determining degree of protection requested by the Departmental Representative.

Protective Class	Protective Measure	Outside Air Temperature for Least Dimension of Section	
		Less than 1 m	More than 1 m
A	Suitable housing plus supplementary Heat or Adequate Insulation	Below 0°C	Below -5°C
B	Suitable covering plus adequate insulation	0°C to 5°C	0°C to -5°C
C	Normal curing no temperature protection required	5°C to 25°C	5°C to 20°C

- .3 Any concrete damaged by freezing or by inadequate protection or curing shall be removed and replaced by the Contractor at no cost to the Department.
- .4 For guidance on adequate insulation, refer to the Canadian Portland Cement Association publication "Design and Control of Concrete Mixtures", Chapter 11.
- .5 Placing
- .1 Concrete to be placed during cold weather shall be within the following temperature limits.

Least Dimension of Section	Concrete Temperature Minimum °C	°C Maximum
Less than 0.3 m	10	27
0.3 m to 1 m	10	27
1 to 2 m	10	25
More than 2 m	5	20

- .2 This temperature can be obtained by heating the water or the aggregate or both; water and aggregate shall then be combined with the mixer first and the temperature of the mixture shall not exceed 38°C when the cement is added.
- .3 When the air temperature is below 0°C the water shall be heated to not greater than 66°C. The aggregates shall be uniformly heated in the stockpiles and/or bins by steam, either injected live or circulated in coils, or by using dry heat before the aggregates are placed in the mixer. Whatever system is used, it shall be designed to give uniform heating that will avoid local overheating which may be injurious to the materials.
- .4 No frozen lump of aggregate will be allowed in the concrete mix and shall be discarded before batching.
- .5 The use of salt, calcium chloride or other chemicals to lower the freezing point or accelerate the set is prohibited.
- .6 The ground, formwork, existing concrete and steel against which concrete is to be placed shall be free from ice and snow before the Departmental Representative will authorize placing to commence. The Contractor shall preheat the area in which the concrete is to be placed, with live steam or moist hot air, this shall also remove snow and ice and heat the contact material to prevent the formation of a cold joint.
- .7 The concrete shall be placed rapidly and evenly, as near to its final position as possible to reduce the risk of segregation, flow lines and cold joints.
- .8 The concrete shall be covered, as quickly as possible after placing.
- .9 Surface moisture evaporation must be kept below 0.75 kg/m<sup>2</sup>/h. Concrete surfaces shall be protected by housing. Protective housing must be wind and weather tight and constructed of suitable materials on a substantial

framework. The framework must be such as to keep the housing at all points 300 mm from the concrete and forms. The housing must have suitable openings to let the concrete be placed and these openings shall be so designed that they may be fully covered and closed as soon as the concrete is placed. The use of "roll back" sheeting or tarpaulins supported on stools is permitted on horizontal surfaces, such as a bridge deck provided the concrete is covered progressively as soon as placed. The housing must be so constructed as to allow a uniform circulation of heat to all parts of the work. This shall include the underside of the bridge deck and beams unless the Departmental Representative has authorized the protection of these areas by fully insulated formwork.

- .10 When mineral fibre is used as insulation, a layer of polyethylene having a minimum thickness of 6 mils shall be placed between the surface of the concrete or formwork and the insulation. This insulation is to be protected from moisture at all times.
- .11 For concrete to be placed between September 1 and April 30, the Contractor shall supply a steam jenny, fully operational and fully capable of adequately protecting all concrete to be placed, when specifically requested by the Departmental Representative.
- .12 The Contractor shall have available, tested and approved, adequate equipment for the heating of the protective housing. Heating will be used to establish and maintain the required curing conditions.
- .13 Contractor shall on the day prior to placing concrete, conduct a trial run to verify his equipment, methods and workmanship to meet the specifications.
- .14 Live wet steam shall be used for heating unless other methods are permitted in writing by the Departmental Representative. Hot air blowers and the like may be used to supplement the steam heating as long as fine water or steam spray into the stream of hot air is provided. The humidity as measured by a wet and dry bulb thermometer shall at no time be less than 95% and the air temperature shall be not less than 13°C.
- .15 The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have

August 2016

- an open flame and intense local heat are prohibited. In the event of any fire of the formwork or housing, the Departmental Representative must be immediately notified.
- .16 The system of heating and positioning of steam outlets so as to give the most uniform distribution possible of the heat is subject to the approval of the Departmental Representative. The Contractor shall make suitable arrangements to stoke boilers outside normal working hours where required. A breakdown in heating is regarded as very serious especially in the early life of the concrete.
- .17 The concrete must be cured in a moist condition and its temperature shall be at least 10°C for seven days after the day of placing.
- .18 Protection shall be withdrawn in such a manner as not to introduce thermal shock stresses in the concrete.
- .19 The temperature of the concrete shall be gradually reduced at a rate not exceeding 17°C per day to that of the surrounding air. To achieve this in a heated housing, the heat shall be slowly reduced and then shut off and the whole housing allowed to cool to within 12°C of the air temperature before the housing itself for the formwork is removed. Where work is to proceed within the same housing on the next stage of the work, the formwork may be removed as soon as the prescribed curing period is over. With fully insulated formwork, the forms themselves may be slackened and some insulation removed if needed. The forms themselves shall not be removed until the temperature of the concrete has fallen to within 12°C of the outside air temperature.

3.11 DEFECTIVE WORK

- .1 Repairs and classification of unacceptable concrete to be in accordance with CSA-A23.1/C23.2.
- .2 Remove defective concrete and embedded debris and repair as directed by Departmental Representative.
- .3 Excessive honeycomb or embedded debris in any concrete shall deem it defective. Remove and replace defective concrete.

- .4 Remove to bare concrete curing compounds detrimental to application of specified finishes.
- .5 Concrete to be supplied at the minimum strength requirement at 28 days. Tests indicating strengths lower than specified will necessitate further testing as required by the Departmental Representative. Cost for such testing to be at the Contractor's expense. Should further tests confirm low values, the Departmental Representative has the right to require strengthening of the affected area or removal and replacing of the weak concrete all to the Contractor's expense.
- .6 Repair all shrinkage cracks in the completed concrete work employing a suitable epoxy injection technique acceptable to Departmental Representative to completely seal all such cracks.

3.12 TOLERANCES .1 Concrete tolerance in accordance with CSA-A23.1/A23.2.