

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 This section includes the following:
- .1 Deep horizontal and vertical concrete repairs.
  - .2 Shallow horizontal and vertical concrete repairs.
  - .3 Concrete crack repairs.
  - .4 Cast-in-place concrete for new structures.
- 1.2 RELATED REQUIREMENTS .1 Section 01 35 28 - 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"

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- 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.
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- 1.5 WASTE MANAGEMENT AND DISPOSAL .1 Separate and recycle waste materials in accordance with the Section 01 74 19 - 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 - 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 28 - 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.

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| 1.9 DELIVERY,<br>STORAGE AND<br>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.  |
| <u>1.10 RESPONSIBILITY</u>               | .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.  |
| <u>1.11 TEMPORARY<br/>SUPPORTS</u>       | .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   |

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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

Deep Concrete Repairs: Measure repairs to any deteriorated concrete surface and/or edge on the existing fishway structure with greater than 25 mm beyond finished surface or edge to sound concrete shall be considered a deep repair. Refer to this section and the drawings for procedures on completing this repair. 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 deep 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 thereafter.

.2 Edge Repairs: Measurement for deep 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 thereafter.

.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 Installation of new reinforcing steel shall be considered incidental to this unit of measure.

.6 All demolition and removal including cleaning and

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- 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.
- .2 Shallow Concrete Repairs: Measure repairs to any deteriorated concrete surface and/or edge on the existing fishway structure with 25 mm or less from the finished surface or edge to sound concrete shall be considered a shallow repair. Refer to this section and the drawings for procedures on completing this repair. 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 shallow concrete surface repairs shall be in square metres (m<sup>2</sup>) of repaired surface area.
- .2 Edge Repairs: measurement for shallow concrete edge repairs shall be in linear metres (lm) of repaired surface length.
- .3 Measurement shall be considered to include finishing of all materials, tools, equipment, agents, falsework, forms, bracing, labour, repair mortar, bonding agents, 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.
- .6 All requirements for hot and cold weather concreting to be considered incidental to this unit of measure.
- .3 Crack Repairs:
- .1 Measure crack repairs in linear metres (lm). Measurement shall be considered to include furnishing of all materials, tools, equipment, and labour required to complete the work, as specified.
- .2 Actual areas and locations of concrete cracks to be repaired and sealed 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.

- .4 Cast-in-Place Concrete (New Structures):
- .1 No separate payment to be made for cast-in-place concrete (new structures) used for the purpose of new staircase foundations. Include all costs incidental to the unit price or lump sum for items where cast-in-place concrete for new structures is required.
  - .2 No separate payment will be made for any other ingredient or feature of concrete work, and all factors, including cold weather placement, reinforcing steel, anchor bolts, joint filler for control joints, cement, plant and labour will be considered as being incidental to the unit price or lump sum for items where cast-in-place concrete for new structures is required.

## 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 75µm sieve size, in excess of 2%. The percentages shall be based on the weight of

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- 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  $\frac{2}{3}$  the clear distance between the reinforcement or  $\frac{2}{3}$  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  $\mu$ m 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.

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- 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.

.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 Epoxy Based Crack Sealant:
  - .1 Two component, 100% solids moisture insensitive epoxy adhesive.
  - .2 For sealing vertical and overhead applications, use gel consistency. Use low viscosity consistency for injection.
  - .3 Primer to be compatible with sealant.
  - .4 Acceptable products include:
    - .1 Euclid Chemical Dural Fast Set Epoxy.
    - .2 BASF: SCB Concrecive 1446.
    - .3 Dayton Superior: Sure Inject (J56).
- .16 Bonding Agent: Cement paste primer for repair

areas and coating for existing rebar:

- .1 Portland cement mortar consisting of a mixture of 1 part cement to 3/4 to 1 part fine aggregate and sufficient water to make a heavy cream consistency. Maximum water to cement ratio of 0.40.
- .2 Pre-manufactured bonding agent/adhesive products can be proposed by the Contractor as an alternate to the cement primer for approval to the Departmental Representative.

.17 Two-Component Concrete Repair Mortar (Shallow Depth Repairs):

- .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 repairs up to at least 25 mm deep.
  - .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 repairs up to at least  
25 mm deep.

.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.

2.2 MIXES

- .1 Concrete strength shall be as shown on the drawings unless particular specifications require higher strength.
- .2 Substitution of concrete mixes of higher 28 day compressive strength than those specified in the contract plans or specifications will be considered. In instances where such substitutions are approved than the Departmental Representative will provide no extra compensation above the tender price for work items which involve the supply and placement of concrete.
- .3 Concrete mixes shall be designed in accordance with CSA Standard CAN/CSA-A23.1 latest edition. Note that ACI standard 211.1 should be used as a guide for determining mix proportions for normal and mass concrete. Verification of the following specified properties through trial batching will be a requirement as a prerequisite to approval of the mix design. In addition, test cylinders may be requested by the Departmental Representative prior to approval of the concrete mix design. The below noted table parameters are subject to change if noted differently in other parts of this specification depending on the application or approved by the Departmental Representative.

PARAMETER	CAST-IN-PLACE (NEW STRUCTURES) (2.3)	LATEX MODIFIED (8)
WATER/CEMENT RATIO	As per approved mix design	0.37 MAX
SLUMP	50 mm to 100 mm	125 MM +30 MM
COMPRESSIVE STRENGTH AT 28 DAYS	35 Mpa	35 MPA
<u>RAPID CHLORIDE PERMEABILITY</u> (ASTM C1202)	Not required	Note Required
AIR CONTENT	5% to 8%	3% TO 6%
AIR VOID SPACING FACTOR (AVERAGE)		--
SPECIFIC SURFACE (AVERAGE)		--
OTHER	.1 Minimum cement content: 385 kg/m <sup>3</sup> of concrete .2 20 mm nominal size (coarse aggregate) .3 Density of air-dry concrete in range of 2240 kg/m <sup>3</sup> to 2400 kg/m <sup>3</sup>	.1 LATEX EMULSION USED IN MIX SHALL HAVE A 46%-49% SOLIDS CONTENT .2 LATEX CONTENT (SOLIDS) IN THE CONTROLS SHALL BE 15% BY WEIGHT AT CEMENT .3 MAXIMUM SIZE AGGREGATE: 10 mm

The above specified tolerances apply to concrete mix production and not to concrete mix design.

NOTES:

- .1 N/A - Not applicable.
  - .2 Cement for concrete shall be Portland Cement Type GU.
  - .3 Mix design for all new concrete structures (35 mPa shall be used for new staircase foundations).
  - .4 Mix design for latex modified (35 mPa) shall be used for deep concrete patch repairs as per part 3.2 of this section.
- .4 The Contractor will be responsible for the mix design and quality control of concrete production.
- .5 The Contractor will submit mix designs for all concrete specified or approved for use on this project. All concrete mix design proportioning including the mix quality control operations shall be performed by a Laboratory CCIL or CSA Certified in accordance with CSA Standard A-283 latest edition. All testing shall be as conducted as stated in CAN/CSA-A23.1 and A23.2 latest edition. The proposed mixture design shall be signed by a Professional Engineer registered to practice in Newfoundland & Labrador. The Professional Engineer shall attest to the validity of the material test data. Proposed mix designs and test results are only considered valid for up to two (2) years in advance of the date of the project mix design submission. The Contractor shall provide with the proposed mix design the following information based on actual trial mixes at least two (2) weeks in advance of concrete placement, unless it is not practical to do so based on project scheduling. In these cases such test results from the proposed mix design previously tested are considered valid for up to two (2) years in advance of the mix design submission for this project:
- Slump CSA A23.2-5C
  - Air Content of Plastic Concrete by Pressure Method CSA A23.2-4C.
  - Mass Density and Yield CSA A23.2-6C.
  - Compressive Strength Testing CSA A23.2-9C.
  - Air Void Analysis on Hardened Concrete tested at 7 days ASTM C457.
  - Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration tested at 56 days ASTM C1202.
  - Alkali Reactivity Test Results A23.2-25A.

- .6 Also to be included with each mix design submission is the following necessary information:
  - Project number and title description
  - Contractor company name with contact information
  - Ready mix supplier
  - Certifying laboratory with signing engineer
  - Type of concrete, intended use, approximate quantity and method of placement
  - Mix slump and air entraining agent range plus all admixtures with dosage rates
  - Aggregate test information as per requirements specified.
- .7 No concrete shall be placed until approval of the mix design has been obtained from the Departmental Representative. The Contractor shall submit copies of the concrete mix design 14 days in advance of any concrete placement operation.
- .8 Once approved, no adjustments shall be made to the concrete mix design without the approval of the Departmental Representative. If material characteristics change after the original mix design approval a revised mix design shall be submitted for approval.
- .9 Acceptance by the Departmental Representative of the Contractor's concrete mix design does not relieve the Contractor of the responsibility for providing concrete which meets the specifications.
- .10 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.
- .11 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 table may not be applicable when using

superplasticizers.

- .12 Samples for concrete testing quality assurance purposes will normally be taken from concrete as delivered to the site (at the point of discharge from the delivery equipment). However, depending on the method of placement, random sampling of the concrete as incorporated into the structure may also be performed to verify the above specified properties. This process shall entail the sampling of fresh concrete as close to the point of deposit in the structure as is practicable. Coring of the in-place hardened concrete may also be performed to verify the specified air void system. The Departmental Representative reserves the right to designate the point of acceptance, with prior notice given to the Contractor.
- .13 Dry batching will not normally be permitted.
- .14 The use of ready mix concrete is encouraged. Where ready mix concrete is to be used, details of scheduling and procedure must be approved by the Departmental Representative.
- .15 The Contractor will be given permission to add cement on site if it is not feasible to have the concrete deposited in the forms within 120 minutes after charging the mixer at the plant. When cement is being added at the site, the total volume of concrete being batched or mixed shall not exceed 85% of the manufacturer's rated drum capacity. Cement shall be added in four equal increments with mixing to be carried out after the addition of each portion of cement added. All equipment, materials and procedure must be approved by the Departmental Representative.
- .16 The mixing of concrete, unless otherwise authorized by the Departmental Representative, shall be done in a batch mixer of an approved type. The mixer shall be equipped with a suitable charging hopper, water storage and water measuring device. It shall be cleaned at frequent intervals when in use and maintained in such a condition that the mixing will be unimpaired.
- .17 The mixing of each batch shall continue not less than one minute after all the materials are in

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the mixer, during which time the mixer shall rotate at a speed of 14 to 20 revolutions per minute, unless otherwise rated by the manufacturer or directed by the Departmental Representative. The Contractor may mix small quantities of concrete by hand when and as directed by the Departmental Representative.

- .18 Concrete transported in a truck mixer, agitator, or other transportation device shall be discharged at the job and placed in its final position in the forms within 120 minutes of the introduction of the mixing water to the cement and aggregate, or the cement to the aggregate, except in hot weather or under other conditions contributing to quick stiffening of the concrete. The maximum volume of mixed concrete transported in an agitator shall be in accordance with the specified rating. Time of charging the truck shall be clearly indicated and excess time in the mixer shall be cause for rejection of a load. Each batch slip shall have the time of batching clearly clock stamped onto each such slip.
- .19 Aggregates shall be separated into fine and coarse. The coarse aggregates shall be graded for mass concrete from 40 mm to 5 mm and for reinforced sections from 20 mm to 5 mm. The equipment for batching on site shall have the capacity to produce at such a rate as to preclude cold joints in the concrete placement. It shall be capable of being charged to the operating capacity of a 16S mixer with one discharge of the batcher. In any event, the equipment is subject to the approval of the Departmental Representative.
- .20 The water and approved admixture(s) shall be proportioned separately by weight or by volume (i.e., metering device(s) to an accuracy of one percent at the mixer). Metering devices which measure the volume of water discharged into the truck shall be in place both at the batch plant and on the truck if water is to be added on site. Alternatively, the water must be manually weighed or measured by volume before being placed into the mixer.
- .21 The Contractor shall provide standard certified test weights and/or devices for checking the accuracy of the controls. Checks shall be made just prior to the first concrete placement and

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at 150 m3 intervals thereafter unless specified otherwise by the Departmental Representative. If the batching plant is moved, a check shall be made prior to batching any more concrete. The Contractor shall carry out all tests in the presence of the Departmental Representative and shall supply him with results of all tests and make any and all alterations, repairs or replacements required to the equipment before authorization will be given to place concrete.

- .22 Obtain approval from Departmental Representative prior to use of pre-packages repair concrete material for site-mixing. Submit product data.
- .23 Obtain the Departmental Representative's approval before using chemical admixtures other than those specified.
- .24 Use of Calcium Chloride not permitted.
- .25 Total repair concrete mix shall not contain more than 0.1% chloride ion by weight of cement.
- .26 Evaporation Retardant - to approval of Departmental Representative.

### 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

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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.
- .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 of 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:

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- .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.
  - .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.
- .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 Where existing reinforcing steel is found to have greater than 15% loss of section, provide additional new bars to splice with existing as per the procedures described in part 3.2 of this section.
  - .31 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.

- .32 Waterstops:
  - .1 Install new waterstops where existing water stops have been removed 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 to field splice waterstops. Tie waterstops rigidly in place.
  - .2 Use only straight heat sealed butt joints in field. Use factory welded corners and intersections unless otherwise approved by Departmental Representative.
- .33 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.
- .34 Apply repair concrete to prepared surfaces immediately after placement of bonding agent/primer.
- .35 Concrete shall not be placed on or against any surface (including rebar) that is at a temperature below 5°C.
- .36 Concrete at time of deposit shall be between 10°C and 30°C, unless noted or approved otherwise.
- .37 Pour concrete continuously between predetermined construction joints. Refer to part 3.1.23 of this specification section.
- .38 Carry out winter concreting in strict accordance with CSA-A23.1/A23.2 and Part 3.14 - Cold Weather Concreting in this section.
- .39 The Contractor is required to supply all cement, bonding agents, and other specialty items to be incorporated in the work.
- .40 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.

- .41 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.
- .42 Concrete, during and immediately after depositing, shall be thoroughly compacted by mechanical vibration.
- .43 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.
- .44 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.
- .45 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.
- .46 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.
- .47 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.

- .48 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 DEEP CONCRETE  
REPAIRS

- .1 General:
  - .1 Repairs to any deteriorated concrete surface and/or edge on the existing fishway structure which requires a repair deeper than 25 mm from the finished surface or edge to sound concrete is considered a deep repair and shall be repaired accordingly.
  - .2 The existing fishway concrete does have some degree of deterioration. Those parts to be repaired will be identified on site with the Departmental Representative.
  - .3 Any dowels or reinforcement which is damaged through negligence and cannot be used as determined by the Departmental Representative, shall be reinstated at the Contractor's expense.
- .2 Removal and Surface Preparation:
  - .1 This work shall entail the removal of deteriorated concrete and surface preparation. All loose, deteriorated and chloride contaminated concrete shall be removed to a minimum depth as indicated on the drawings, beyond original lines or further until sound concrete as determined by the Departmental Representative. If any rebar is corroded, presently exposed or exposed by concrete removal, then the concrete surrounding the rebar shall be removed to a clear distance of 25 mm beyond the steel. Continue to expose reinforcing steel along its length until at least 50 mm of sound rust free material is exposed. Concrete removal shall be as detailed on the drawings and as directed by the Departmental Representative.
  - .2 Prior to restoration of the deteriorated areas, all exposed reinforcing steel designated to remain shall be satisfactorily sand-blasted

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- until the steel is free of all rust to SSPC-SP6, commercial blast clean. Fine particles of cement or sand shall be removed by vacuum or with jets of oil-free compressed air.
- .3 If concrete is to be removed by jackhammer, the maximum hammer mass permitted is 13 kg. Maximum hammer size permitted when removing material around reinforcing steel shall be 7 kg.
- .4 Where fresh concrete will meet hardened concrete, a 30 mm deep saw cut shall be used to obtain straight clean lines and to preclude feather-edging.
- .5 Roughen surface of parent concrete to full amplitude of at least 5 mm and remove all loose material prior to application of cement paste.
- .6 Existing reinforcement exposed during concrete removal that is designated to remain shall be secured in position as necessary. Care and caution shall be taken during the removal of concrete as not to damage the existing reinforcement and inserts. In areas where the existing reinforcement is corroded to less than 15% loss of section, continue to expose reinforcing steel along the length until at least 50 mm of sound rust free material is exposed. In any areas where corrosion of rebar has resulted in greater than 15% loss of section, or the rebar is damaged beyond salvage (as determined by the Departmental Representative), a bar of same type and area shall be spliced to sound steel and extend over full area of corrosion or damage and concrete removed as required to complete this work. The Contractor is responsible for all field measurements necessary to have shop fabricated reinforcing bars bent and cut to suit the required locations. All exposed reinforcement designated to remain shall be cleaned to SSPC-SP6, Commercial Blast Clean.
- .7 During the concrete removal and placing operations, care should be taken to keep contaminants off newly exposed surfaces.
- .8 All machinery that might leak oil should be kept off this area of deck when possible. If machinery such as a compressor has to be on this portion of the deck, plastic polyethylene sheets should be placed under it and extreme care should be taken when refueling. Air compressors must be equipped with a functioning oil trap.

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- .9 Forty-eight (48) hours of good curing shall have elapsed prior to scarifying and/or chipping on adjacent concrete within 2 meters of a newly placed overlay.
  - .10 If a spill does occur, the Contractor at his own expense shall have it wiped up and the contaminated concrete chipped away immediately. The fishway shall be kept clean on a daily basis.
  - .11 The exposed reinforcing steel and the remaining sound concrete must be protected when heavy loads pass over them.
- .3 Concrete Supply & Placement:
- .1 The Contractor shall inform the Departmental Representative of areas ready for new concrete or mortar placement at least 24 hours in advance of placement to allow for inspection and measurement. No concrete shall be placed until the prepared surface to be restored is inspected and approval in writing is given by the Departmental Representative.
  - .2 These areas shall then be restored to the original lines using a latex modified concrete, having a 28 day compressive strength of 35 MPa, maximum water:cement ratio of 0.37, 3% to 6% entrained air, 125 mm  $\pm$  30 mm slump and maximum size aggregate of 10 mm, or an approved equal repair mortar. The latex emulsion used in the mix shall have a 46% - 49% solids content and the latex content (solids) in the concrete shall be 15% by weight of cement.
  - .3 All aspects of concrete supply and placement are subject to approval by Departmental Representative.
  - .4 The use of superplasticizers to ensure the proper consolidation of concrete will be permitted subject to the Engineer's approval of the concrete mix design, however, the Contractor must demonstrate competence and experience in their use and specific approval must be obtained.
  - .5 Latex modified concrete shall be mixed by mechanical mixer and placed within 20 minutes of batching.
  - .6 The use of a pre manufactured compound for large deep repairs may be used in place of latex modified concrete if approved by the Departmental Representative.

- .4 Finishing:
  - .1 Concrete finishing shall be in accordance with Part 3.8 of this specification section.
- .5 Curing:
  - .1 All aspects of curing shall be in accordance with Part 3.10 of this specification book.

3.3 SHALLOW CONCRETE .1  
REPAIRS

- .1 Repairs to any deteriorated concrete surface and/or edge on the existing fishway structure which requires a repair no deeper than 25 mm from the finished surface or edge to sound concrete is considered a shallow repair and shall be repaired 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 (5-20 mm deep, no feather edges), chipping, high pressure water blasting or other appropriate mechanical means with equipment approved by the Departmental Representative down to sound concrete (less than or equal to 25 mm). Obtain substrate aggregate fracture with minimum surface profile of +/- 3 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 approved bonding agent compatible with the repair mortar, into the substrate, filling all pores, voids and edges and completely

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- 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.
  - .7     Concrete repairs with depth to sound concrete greater than 25 mm shall be repaired in accordance with the deep Concrete Repair procedures indicated in Part 3.2 of this specification.

#### 3.4 CRACK REPAIR

- .1     Repair all cracks in sound concrete as identified on site with the Departmental Representative. Repair shrinkage cracks that develop in new concrete repairs and along the cold joints between new and existing concrete.
- .2     Remove laitance, curing, compounds, dust, dirt, sludge, oil and other debris from surfaces prior to application of crack repair.
- .3     All concrete surfaces shall be dry unless a water-insensitive coating is used. Surface temperature shall be at least 4°C.
- .4     Install injection ports at appropriate intervals to accomplish full penetration of injection

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material.

- .5 Seal the exposed crack between the injection ports with epoxy based crack sealant.
- .6 Install injection epoxy sealant material with pressure.
- .7 Immediately remove excess epoxy sealant applied or spilled beyond desired areas.
- .8 Remove all injection ports by grinding or other appropriate method. Fill core holes with grout.
- .9 For cracks larger than 3 mm wide in sound concrete or cracks in damaged or unsound concrete conduct the appropriate patch repair procedure as per part 3.2 and 3.3 of this section.

3.5 CAST-IN-PLACE  
CONCRETE FOR NEW  
STRUCTURES

- .1 General
  - .1 The work will entail the following.
    - .1 New staircase foundations.
- .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.
  - .2 Any rock removal shall be completed in accordance with Section 31 23 17 - Rock Removal.
- .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 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

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- 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%.
- .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.

3.6 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.

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

### 3.8 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

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- 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.
- .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

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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.

3.9 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.

3.10 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

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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.

3.11 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.

3.12 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

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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

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- 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  $0.75 \text{ kg/m}^2/\text{h}$ . 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

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- 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 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

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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.

3.13 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.

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