

1.0 GENERAL

1.1 FAMILIARIZATION WITH SITE

- .1 Before submitting their tender, it is recommended that tenderers inspect and examine the site and its surroundings and satisfy themselves as to the form and nature of the work and materials necessary for the completion of the work, the means of access to the site, the accommodation they may require, and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their tender. No allowance shall be made subsequently in this connection on account of error or negligence to properly observe and determine the conditions that will apply.

1.2 REPAIR QUANTITY DETERMINATION

- .1 Length and width shall be measured to the nearest 25mm.

1.3 REFERENCE STANDARDS

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| .1 | CSA-A23.1-14 | Concrete Materials and Methods of Concrete Construction |
| .2 | CSA-A23.2-14 | Methods of Test for Concrete |
| .3 | CSA-A3000-13 | Cementitious Materials for Use in Concrete |
| .4 | ASTM C109/C109M-08 | Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in or 50-mm cube specimens) |
| .5 | ASTM C348-08 | Standard Test Method For Flexural Strength of Hydraulic Cement Mortar |
| .6 | ASTM C207-06 | Standard Specifications for Hydrated Lime for Masonry Purposes |
| .7 | ASTM C157/C157M-08 | Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete |
| .8 | ASTM C348-08 | Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars |
| .9 | ASTM C882/C882M-05e1 | Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear |

1.4 PERFORMANCE REQUIREMENTS

- .1 The surfaces shall not scale or crack excessively.
- .2 The concrete repair materials shall not spall or debond from the existing concrete.

1.5 SUBMITTALS

- .1 Submit all mix designs, product specifications, and manufacturer's recommendations for review by the Departmental Representative, a minimum of two weeks prior to placement or use of products.
- .2 Submit details of proposed methods of concrete curing and provisions for weather protection to the Departmental Representative for review a minimum of two weeks prior to placement.
- .3 Submit manufacturer's product data sheets for proposed curing compounds, admixtures and corrosion inhibitors.
- .4 Do not commence placement of concrete until review is complete and proposed products and procedures are accepted by Departmental Representative.

1.6 MOCK-UPS FOR BOARD FORM FINISH

- .1 Mock-ups: field-erected examples of work complete with specified materials and workmanship.
- .2 Erect mock-ups for the board form finish at locations acceptable to Departmental Representative.
- .3 Reviewed and accepted mock-ups will become standards of workmanship and material against which installed work will be verified.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Portland Cement to be type GU to CSA-A3000.
- .2 Aggregate: Natural stone to CSA-A23.1.
- .3 Water: Potable and to CSA-A23.1.
- .4 Air entraining agents to CSA –A3000.
- .5 Chemicals admixtures to CSA-A3000. Calcium chloride is not permitted.
- .6 Pozzolanic mineral admixtures to CSA-A3000.
- .7 Curing materials to CSA-A23.1.
- .8 Blended hydraulic cementing material to be type 10SF to CSA-A3000.
- .9 Supplementary cementing material to be to CSA-A3000.
- .10 Superplasticizing admixture to be to CSA-A3000.

2.2 SURFACE AND THROUGH SLAB DELAMINATION REPAIR CONCRETE MIX – SILICA FUME

- .1 Normal weight “ready mixed” Portland cement/silica fume modified concrete mixed in accordance with Section 15, CSA-A23.1 class of exposure C-1 with the following requirements:

	<u>Description</u>	<u>Requirements</u>
.1	Compressive strength (28 days)	35 MPa minimum
.2	Air content	6.0% to 9.0%
.3	Aggregate size	13 mm
.4	Slump	
	Prior to superplasticizer	50 mm maximum +/- 20mm
	After superplasticizer	125 mm maximum +/- 25mm
.5	Water/cementing materials ratio	0.40 maximum
.6	Cement content	335 kg/m ³ minimum
.7	Cement –Type GU	Normal Portland Cement
.8	Silica Fume – Type U	Minimum 7.5 % Silica Fume by mass of cement (25 kg/m ³ . min.)
.9	Fly Ash – Type F	Maximum 15% by mass of cement (50 kg/cu. m. max)
.10	Concrete density	Normal weight (2360 kg/m ³)

- .2 The intent of this mix design is to provide a low permeability, high electrical resistivity concrete mix with a coulomb rating less than 1500.
- .3 Non-chloride based plasticizers shall be used to facilitate concrete placement as required. Costs associated with the use of such materials shall be included in the contract price. Plasticizer shall be compatible with the air entrainment agent.
- .4 Note that although a maximum slump is specified, the Contractor shall endeavour to provide concrete at the minimum slump that permits placement and handling.
- .5 Mix design is the responsibility of the Contractor.
- .6 Do not add calcium chloride to concrete.
- .7 Addition of water to the concrete mix shall not be permitted on-site. The Contractor shall be permitted to adjust only the quantities of superplasticizer and air entraining agent on-site.
- .8 No concrete shall be placed later than two (2) hours after the time of batching. No re-tempered concrete shall be allowed.

- .9 The Contractor shall use superplasticizers to facilitate concrete placement and must demonstrate to the satisfaction of the Departmental Representative that such admixtures will have no deleterious affect on the durability or strength of the proposed concrete mix (i.e. freeze/thaw durability).

2.3 CEMENT SLURRY BONDING AGENT

- .1 Cement slurry grout consisting of a mixture of one part cement to one part fine aggregate conforming to CSA Standard CSA-A23.1 and sufficient water to make a “heavy cream” consistency.

2.4 EVAPORATION REDUCER

- .1 Monomolecular film to be applied to the surface of the screeded concrete to combat rapid drying conditions. Application required on silica fume concrete placed in direct sunlight, high winds, heated interiors, and interior or exterior low humidity conditions. Conform to manufacturer’s recommended procedures and application rates.

2.5 CONCRETE ADHESIVE ANCHORING SYSTEM

- .1 Concrete adhesive anchoring system to meet the assessment criteria of ACI 355.4. System to be suitable for intended purpose, including embedment of concrete reinforcing bars.
- .2 Submit manufacturer’s technical information for anchoring system, including anchor capacity values for various substrates.
- .3 Threaded rod for adhesive anchors to be type 316 stainless steel to ASTM F593 CW2.
- .4 Follow manufacturer’s recommended installation procedure based on published technical literature.

2.6 EXPANSION ANCHORS

- .1 Expansion anchoring system to meet the assessment criteria of ACI 355.2. System to be suitable for intended purpose.
- .2 Submit manufacturer’s technical information for anchoring system, including anchor capacity values for various substrates.
- .3 Anchors to be AISI Type 316 stainless steel.

- .4 Follow manufacturer's recommended installation procedure based on published technical literature.

3.0 EXECUTION

3.1 CONCRETE SURFACE PREPARATION

- .1 All concrete repair substrates to receive new concrete shall be thoroughly abrasive – blast, sandblast or shotblast prior to concrete placement, unless surfaces have received hydrodemolition acceptable to Departmental Representative.
- .2 Clean all existing concrete surfaces to receive new concrete of foreign material, dust, debris, grease and oil; emulsifiers shall be required for surfaces containing grease or oil as directed by Departmental Representative.
- .3 Contractor to notify Departmental Representative to review surfaces prior to concrete placement.

3.2 CONCRETE REPLACEMENT - READY-MIXED CONCRETE

- .1 The patch area shall be thoroughly wetted for a period of not less than twenty-four (24) hours prior to placing of concrete.
- .2 Puddles or free water shall be blown clear of concrete prior to application of cement slurry.
- .3 Just prior to placing new concrete, apply a cement slurry bonding agent to the surface of the concrete.
- .4 The bond coat slurry shall be broomed into the deck to fully saturate the surface but not to be allowed to puddle.
- .5 Use only qualified concrete placers and finishers, with a minimum of two years experience in similar work.
- .6 Prior to placement of concrete, pre wet burlap shall be on site available for immediate placement overtop of new concrete patches.
- .7 **Do not add extra water to the concrete.**

- .8 On slab top surfaces place new dense concrete thoroughly compacted and vibrated into place to ensure good bond.
 1. Ensure reinforcing steel is secured in place and is not disturbed during placement.
 2. Vibrators shall be inserted into concrete perpendicular to concrete surface.
 3. Vibrators shall be inserted such that zones of consolidation always overlap.
- .9 Concrete surfaces to be flush with existing surfaces leaving no voids at patch edges.
- .10 Do not overwork concrete surface. Wood float finish is acceptable. **Do not add water to finish.**
- .11 Tool crack control joints as indicated on Drawings.
- .12 Do not cover concrete repair patches with waterproof membrane until curing period of repair patch material is complete and the surface is completely dry. Concrete shall be considered sufficiently dry if no moisture is visible on the underside of 18" x 18" sheet of polyethylene plastic taped to the slab surface for 16 hours. Allow fourteen (14) days for drying, after moist curing.
- .13 Areas of concrete repair completely through the thickness of the slab shall be patched with concrete, well consolidated and vibrated into place on to smooth plywood forms with suitable release agents adequately shored from the slab below, to the approval of the Departmental Representative. Once forms have been removed edges of through slab repair are to be grinded, hand patched, etc. as required to produce smooth (form like) transition from new patch material to the existing slab.
- .14 Do not allow traffic on newly placed repair patches until 75% of the specified 28 day strength has been reached, unless otherwise directed by the Departmental Representative.

3.3 CONCRETE SURFACE - REPAIR OF SURFACE SCALING

- .1 The concrete surface shall be sandblast to remove all deteriorated concrete, laitance and loose aggregate; to a minimum Concrete Surface Profile (ICRI –CSP) of 7.

- .2 Slab surfaces shall be cleaned of all grease and oil.
- .3 Areas where the slab surface has deteriorated greater than 6 mm in total depth are to be filled with patching materials in accordance Section 03 01 29.
- .4 Thoroughly clean patch of dust and debris.
- .5 Prepare surfaces and place concrete mixture in strict accordance with CSA 23.1.
- .6 Surfaces to be trowelled smooth, flush with existing surfaces, leaving no voids at patch edges.

3.4 CONCRETE MIXING AND PLACING

- .1 Concrete shall be machine mixed. Mixing and placing shall be in accordance with CSA-A23.1.
- .2 Concrete shall be conveyed from the mixer to the place of deposit by methods that will ensure the required quality of concrete. Equipment for conveying the concrete shall be of such size and design as shall ensure a practically continuous flow of concrete at the delivery end without separation of materials.
- .3 Concrete shall be deposited in the forms as nearly as practicable to its final position to avoid rehandling.
- .4 Depositing shall be continuous throughout each division and the concrete shall be so placed and worked that a uniform texture will be produced.
- .5 No concrete shall be placed later than one half hour after leaving the mixer. No retempered concrete shall be allowed.

3.5 COMPACTION AND VIBRATION

- .1 Concrete shall be consolidated by means of sufficient vibrators of adequate size operated by competent workmen.
- .2 The use of vibrators to transport concrete shall not be allowed.
- .3 Concrete shall be thoroughly worked around reinforcement, around embedded items and into corners of forms, eliminating all air or stone pockets that may cause honeycombing, pitting or planes of weakness.

3.6 CONCRETE CURING

- .1 Fog-mist curing methods or evaporation retarder must be incorporated by the Contractor, in order to prevent loss of moisture from the surfaces of the placed concrete, in all rapid drying conditions. Rapid-drying conditions may include any of the following: high concrete ambient temperatures, low humidity, high winds, direct sunlight, or heated interiors during cold weather. In these conditions, fog-mist curing shall be initiated immediately after initial finishing, and continued until concrete is covered with wet-curing mats.
- .2 As soon as possible after the concrete has sufficiently set, and no later than 30 minutes after finishing, wet curing with pre-saturated mats shall be initiated on the concrete surfaces.
 - .1 Wet curing procedures shall ensure that the concrete surfaces shall be kept continuously wet for a period of at least ten (10) consecutive days at a minimum temperature of 10 deg. Celsius. Water shall not be permitted to evaporate from the concrete surfaces at any time within the wet cure period.
 - .2 Minimum acceptable wet curing method on slab surfaces is pre-saturated filter fabric, burlap, or cotton mats; covered with soaker hoses and plastic sheeting. Wet-curing mats shall be overlapped 150-mm and held in place without marring the surface of the concrete.
 - .3 Prevent airflow in the space between the wet-curing mats and the plastic sheeting. Protect wet-curing assembly from freezing during cold weather.
- .3 Vertical repair patches are also to be wet cured, for the duration of the wet-curing period.
 - .1 Formwork may remain in place on vertical surfaces for the duration of the curing period, however, form ties shall be loosened after the concrete has hardened, and water applied to run down the inside form faces to keep the vertical concrete surfaces wet.
 - .2 Alternatively, formwork may be removed from vertical surfaces provided that exposed concrete surfaces are kept continuously wet using a fog misting, light water spray, or application of wet burlap covered with polyethylene.
 - .3 Continuous water curing of exposed beam and slab soffit repairs is not required, however, exposed concrete soffit surfaces shall be misted with a

water spray during the wet-curing period, on a daily basis or as necessary to prevent surface dusting of the concrete soffits.

- .4 Contractor shall review fog-curing and wet-curing requirements with the Departmental Representative at least 2-weeks prior to first concrete placement. The Contractor must submit any proposed alternate curing methods to the Departmental Representative for review a minimum of one-week prior to placement.
- .5 Use of chemical curing compounds shall not be permitted.
- .6 Concrete shall be protected from harmful effects of heat, cold, running or surface water, and mechanical shock.
- .7 When the air temperature is below 10 deg. C or when in the opinion of the Departmental Representative, there is a possibility of it falling below 10 deg. C no concrete shall be placed until after the Departmental Representative has approved the provisions made to ensure proper curing of concrete. These provisions shall conform to the requirements of CSA-A23.1.
- .8 Adequate equipment shall be provided for heating the concrete materials and protecting the concrete from freezing or near freezing temperatures. No frozen materials or materials containing ice shall be used. All concrete materials and all reinforcement, forms, existing concrete and ground with which the concrete is to come into contact, shall be free from frost. Whenever the temperature of the surrounding air is below 5 deg. C all concrete placed in the forms shall have a temperature of between 15 deg. C and 32 deg. C and adequate means shall be provided for maintaining a temperature of not less than 10 deg. C for 10 days or for as much more as is necessary to ensure proper curing of the concrete. Under no circumstances may dry heat be used. Means shall be taken to humidify the air within the enclosure and to ensure that the moisture requirements for curing are maintained.
- .9 Do not allow traffic onto patch until material has adequately cured to 70% of its specified 28-day compressive strength.
- .10 In the event that the Contractor's wet curing procedures are unacceptable, and any portion of the concrete becomes surface dry during the specified curing period, the Departmental Representative will have cause to reject the concrete.

3.7 INSPECTION AND TESTING

- .1 To conform to CSA-A23.2.

- .2 Inspection and testing to be conducted by a testing agency designated by the Departmental Representative. The Departmental Representative will pay costs of inspection and testing described in this section.
- .3 Contractor to inform testing agency 24 hours in advance of concrete placement.
- .4 Testing shall include:
 - .1 Prepare and test concrete test cylinders for compressive strengths.
 - .2 Establish slump and percentage of entrained air for each concrete truck unless otherwise directed by Departmental Representative.
 - .3 Review concrete mix designs submitted by the Contractor.
 - .4 Bond tests of concrete patches to existing concrete as designated by Departmental Representative.
 - .5 Submit one copy of the test results directly to the Departmental Representative, the Departmental Representative, and the Contractor.
 - .6 A minimum of one set (4 cylinders) of concrete cylinders shall be taken for concrete patch material used each day for compressive tests, unless otherwise directed by Departmental Representative. Concrete cylinders are to be placed in an area with similar curing conditions to that of the cast concrete.
- .5 Testing procedures for concrete shall conform to the following requirements:
 - .1 Compression tests on concrete shall be carried out in accordance with CSA Standard A23.2 and A23.1 except that a Strength Test shall consist of four test cylinders and one cylinder shall be tested at the age of three (3) days, the second cylinder shall be tested at the age of seven (7) days and the remaining two at an age of 28 days.
 - .2 Slump and air entrainment test shall be conducted at the time of sampling concrete for compressive tests and shall be conducted in conformity with CSA Standard A23.2. Slump and air entrainment tests shall be performed on all loads used each day.

- .6 The Contractor shall provide at no additional costs to the Departmental Representative:
 - .1 Samples of all material required for testing.
 - .2 Co-operation with the execution of concrete testing which shall include protection against injury or loss of cylinders.
 - .3 Access to the Testing Company to test and/or inspect materials.
 - .4 Site storage facilities meeting requirements of CSA A23.2 for concrete test specimens prior to removal to laboratory.
- .7 Bond Strength:
 - .1 After the concrete has cured (10 days minimum) the Testing Company may perform bond strength tests if requested by Departmental Representative. Testing Company will drill through patches selected by Departmental Representative.
 - .2 These cores are to be used for the evaluation of the bond strength of the new concrete to the existing by direct tensile force.
 - .3 Failure to achieve a minimum tensile bond strength as specified under this section, or 0.7 MPa if not otherwise specified shall constitute failure of patches.
 - .4 Upon completion of the tests, all core holes are to be filled with non-shrink cementitious grout, by the Contractor.
- .8 Contractor shall pay for costs of additional testing as follows:
 - .1 Additional standby time required due to late delivery by concrete supplier.
 - .2 Additional slump and/or air tests if first tests indicate concrete properties out of spec and Contractor wishes to modify mix and retest for acceptance. All modifications to be approved by the Departmental Representative.
 - .3 If Contractor fails to notify testing agency in event of pour cancellation.

3.8 INSPECTION AND TESTING – ADHESIVE AND MECHANICAL ANCHORS

- .1 The following testing is to be paid for by PWGSC:
 - .1 Proof load test 10% of epoxy anchors to manufacturer's specified capacity
 - .2 Randomly select 2% of epoxy anchors for testing to failure. Contractor to replace anchors at the Contractor's cost.
- .2 The following testing is to be paid for by the Contactor:
 - .1 100% testing of the anchors if any proof load tests fail
 - .2 100% testing of the anchors if anchors are found to be with incomplete epoxy of embedded less than 90% of specified embedment based on the manufacturers requirements
- .3 The testing agency is to provide a repair and testing report sealed by a professional engineer registered in the province of New Brunswick.

3.9 FIELD QUALITY CONTROL

- .1 The Departmental Representative shall evaluate bonding of fresh patch material to existing concrete after the fresh patch material has cured sufficiently.
- .2 The evaluation shall be performed by sounding, using a "chain-drag" or other techniques.
- .3 Detection of hollow sound in any areas shall be reason to suspect inadequate bonding and Contractor shall then core each such are, as requested by the Departmental Representative, to determine bonding adequacy.
- .4 Coring shall be through the new concrete and into the existing concrete. Core diameter shall be 75mm or as required by the Departmental Representative. Length of cores shall be twice the core diameter or twice the thickness of new concrete or as requested by the Departmental Representative.
- .5 Cores will be visually inspected and further testing required, if any, will then be determined by the Departmental Representative.
- .6 Contractor to patch core holes.

3.10 REJECTION OF DEFECTIVE WORK

- .1 In the event that concrete tests do not conform to the requirements of this specification, the Departmental Representative shall have the right to order additional tests of any portion of the repairs in accordance with CSA Standard A23.1. The testing company shall be selected by the Departmental Representative and shall deal directly with the Departmental Representative; such tests shall be made at the expense of the Contractor.
- .2 Where, in the opinion of the Departmental Representative, materials or workmanship fail to meet the requirements of the specification, such work or materials will be rejected. Work rejected shall be replaced or repaired to the approval of the Departmental Representative and at no additional cost to the Departmental Representative.
- .3 Failure of the bond between the topping and the existing concrete at any of the core specimens or failure of the compression tests will require additional core samples to be drilled at the expense of the Contractor. Subsequent failure of these additional samples shall result in rejection of the repair areas represented.

3.11 RECORD DRAWINGS

- .1 Maintain accurate records of locations, size of each repair area and dates of all concrete repairs and concrete pours.
- .2 Records to be kept up to date and made available to Departmental Representative throughout the duration of the Work.
- .3 Prior to Substantial Performance provide a plan showing location, size, and date of concrete repairs.

END OF SECTION