

1.0 GENERAL

1.1 WORK SEQUENCE

- .1 Provide all labour, materials, equipment and supervision necessary to prepare surface of patch repairs (i.e. slab surfaces, slab soffits, columns, walls and beams) and place new concrete repair material as outlined in this Section.
- .1 The concrete repair materials are to be used in targeted repair locations as directed by the Departmental Representative:
 - .1 Concrete collar base.
 - .2 Exterior concrete walls, including accents and features.
 - .2 Gallery level slab.

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 | Test Methods and Standard Practices for Concrete |
| .3 | CSA-A3001 | Cementitious Materials for Use in Concrete |
| .4 | ASTM C109-M1999 | Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2 inch or 50 mm cube specimens) |
| .5 | ASTM C348-97 | Standard Test Method For Flexural Strength Of Hydraulic Cement Mortar |
| .6 | ASTM C882 | Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear |
| .7 | ASTM C157-99 | Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete |

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.
- .3 The concrete repair materials shall achieve a minimum compressive strength of 20MPa within 24 hours.

1.5 SUBMITTALS

- .1 Submit Manufacturer's product specifications, data sheets, instructions and recommendations for the following products:
 - .1 Cement slurry bonding agent
 - .2 Rapid cure surface delamination repair material
 - .3 Vertical/Overhead patch material
 - .4 Concrete resurfacing material
 - .5 Pressure grout
 - .6 Admixtures
 - .7 Non-shrink grout
 - .8 Dry pack
 - .9 Evaporation reducer
 - .10 Corrosion inhibitor
 - .11 Concrete adhesive anchoring system
 - .12 Expansion anchors
- .2 Submittals to be provided to the Departmental Representative to review, a minimum of two weeks prior to placement or use of products.
- .3 Do not commence placement of repair products until review is complete and proposed products and procedures are accepted by Departmental Representative.
- .4 If requested by Departmental Representative, provide a certificate signed by the Contractor and pre-packaged material manufacturer certifying the following:
 - .1 Surfaces to receive pre-packaged materials were acceptable and found to be satisfactory to receive the materials, as per the Manufacturer's requirements and these Specifications. Application of pre-packaged materials shall imply acceptance of surfaces.
 - .2 Pre-packaged materials were installed in accordance with Manufacturer's recommendations and these Specifications.

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-A3001
- .2 Aggregate: Natural stone to CAN/CSA-A23.1
- .3 Water: Potable and to CAN/ CSA-A23.1
- .4 Air entraining agents to CSA –A3001
- .5 Chemicals admixtures to CSA-A3001. Calcium chloride is not permitted.
- .6 Pozzolanic mineral admixtures to CSA-A3001
- .7 Curing materials to CSA-A23.1
- .8 Blended hydraulic cementing material to be type 10SF to CAN/CSA-A362.
- .9 Supplementary cementing material to be to CAN/CSA A23.5.
- .10 Superplasticizing admixture to be to CSA-A3001.

2.2 CEMENT SLURRY BONDING AGENT

- .1 Unless otherwise stipulated by the manufacturer, cement slurry grout consisting of a mixture of one part cement to one part fine aggregate conforming to CSA Standard CAN/ CSA A23.1 and sufficient water to make a “heavy cream” consistency.
- .2 Prior to placement of repair material, Contractor to confirm in writing manufacturer’s recommended slurry bonding agent.

2.3 RAPID-CURE SURFACE DELAMINATION REPAIR MATERIAL

- .1 Proportion patch materials with specially graded aggregate to give the following properties:

	<u>Description</u>	<u>Requirements</u>
.1	Compressive strength (24 hours)	20 MPa minimum
.2	Compressive strength (7 days) (ASTM C109-86 modified).	30 MPa minimum
.3	Flexural Strength (7 days) (ASTM C348 modified).	5 MPa minimum
.4	Bond Strength (7 days) (ASTM C882).	5 MPa minimum
.5	Linear shrinkage: (ASTM C157)	0.08% max.
.6	Rapid chloride permeability (ASTM C 1202)	less than 1,000 coulombs
.7	Thermally compatible with concrete substrate under all applicable service conditions.	

- .2 Manufacturer's latest product data sheets must be submitted for patch materials to be used on this project certifying the patch material conforms to the specified requirements.

2.4 VERTICAL/OVERHEAD DELAMINATION REPAIR MATERIAL

- .1 Overhead patch materials shall be polymer modified cementitious, fast-setting, and formulated especially for repair of overhead and vertical surface concrete patching
- .2 Patch materials to have the following properties:

	<u>Description</u>	<u>Requirements</u>
.1	Compressive strength (28 days) (ASTM C109-13 modified).	30 MPa minimum
.2	Flexural Strength (7 days) (ASTM C348 modified).	5 MPa minimum
.3	Bond Strength (7 days) (ASTM C882).	5 MPa minimum
.4	Linear shrinkage: (ASTM C157)	0.10% max.
.5	Rapid chloride permeability (ASTM C 1202)	less than 1,000 coulombs
.6	Thermally compatible with concrete substrate under all applicable service conditions.	

- .3 Manufacturer's latest product data sheets must be submitted for patch materials to be used on this project certifying the patch material conforms to the specified requirements.

2.5 CONCRETE RESURFACING MATERIAL

- .1 Proportion patch materials with specially grade aggregate to give the following properties.

	<u>Description</u>	<u>Requirements</u>
.1	Compressive strength (24 hours)	20 MPa minimum
.2	Compressive strength (7 days) (ASTM C109-86 modified).	30 MPa minimum
.3	Flexural Strength (7 days) (ASTM C348 modified).	5 MPa minimum
.4	Bond Strength (7 days) (ASTM C882).	5 MPa minimum
.5	Linear shrinkage: (ASTM C157)	0.08% max.
.6	Thermally compatible with concrete substrate under applicable service conditions.	

- .2 Manufacturer's latest product data sheets must be submitted for patch materials to be used on this project certifying the patch material conforms to the specified requirements.

2.6 PRESSURE GROUT – SLAB SOFFIT AND VERTICAL SURFACES

- .1 Pressure grouting materials shall have Silica Fume: 8 – 10% by mass of cement.

2.7 ADMIXTURES

- .1 Use only compatible admixtures and add to mix in strict accordance with manufacturer's recommendations.
- .2 Use of calcium chloride not permitted.

2.8 NON-SHRINK GROUT

- .1 Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, of pouring consistency, capable of developing compressive strength of 35 MPa at 28 days.

2.9 DRY PACK

- .1 Premixed or non-premixed composition of non-metallic aggregate, cement and sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 35 MPa at 28 days.

2.10 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.

2.11 CORROSION INHIBITOR

- .1 Apply a corrosion inhibitor to repair areas where it is not possible to remove concrete around the full perimeter of existing reinforcing bars.
- .2 Contractor shall make every reasonable attempt to avoid the need to use corrosion inhibitor under this application to the satisfaction of the Departmental Representative.

2.12 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.

2.13 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 repair material shall be thoroughly abrasive – blast, sandblast or shot blast prior to concrete placement.
- .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 PLACEMENT – SURFACE REPAIRS

- .1 Prepare patch surface, mix patch material, and apply, finish, and cure in strict accordance with the more rigorous requirements of Contract Specifications and manufacturer's recommendations.
 - .1 The patch area shall be thoroughly wetted and saturated with water for 24 hours prior to placing of concrete repair material.
 - .2 Allow patch to become surface dry, puddles or free water shall be blown clear of patch, 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 repair areas.
 - .7 Prepare pre-packaged concrete mix as per Manufacturer's specifications.
 - .8 Contractor to confirm the minimum and maximum application lift thickness prior to placement of concrete. If required and permitted by the Manufacturer, the concrete repair material can be extended with aggregate. **Contractor to submit proposed aggregate extension mix**

design to the Departmental Representative prior to proceeding with Work.

- .9 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.
- .10 Concrete surfaces to be flush with existing surfaces, free of voids and cracks, and have a uniform surface and transition to the existing surface.
- .11 Do not overwork concrete surface. Wood float finish is acceptable. **Do not add water to finish.**
- .12 Cure concrete as per manufacturer's written instruction.

3.3 CONCRETE PLACEMENT – PRESSURE GROUTING

- .1 On slab soffits and vertical surfaces place new dense concrete by pressure grouting.
- .2 Thoroughly wet prepared surface for a period of one (1) hour prior to placement.
- .3 Design forms to resist pressure of contained grout and seal against grout leakage until set.
- .4 Forms to be adequately supported to maintain position during grout pumping and setting.
- .5 Treat bond line between old and new concrete as per grout manufacturer's specifications to ensure adequate bond.
- .6 Pressure fill the repair area with pumpable, non-shrink cementitious grout to completely fill the void area with good bond to existing concrete.
- .7 Remove all form work, support brackets, to leave a smooth, flush concrete finish. Formwork to remain in place for minimum seven (7) days for cure, or longer until concrete has attained 75% of its specified 28 day strength.

- .8 Once forms have been removed, where required in accordance with the Departmental Representative's direction, edges of repair areas are to be grinded, hand patched, etc. as required to produce a smooth (formlike) transition from the new patch surface to the existing concrete surface.
- .9 Apply approved curing compound as recommended by grout manufacturer.
- .10 Grout that has sagged, debonded, is porous, honeycombed, or is cracked shall be replaced.

3.4 CONCRETE PLACEMENT – VERTICAL SURFACES (GRAVITY GROUTING)

- .1 Supply and install formwork to conform to Section 03 10 00 - Concrete Formwork.
- .2 The patch area shall be thoroughly wetted for a period of not less than twenty-four (24) hours prior to placing of concrete.
- .3 Place new concrete into forms by gravity method, thoroughly consolidate concrete in forms using vibrators.
- .4 Remove all form work, support brackets, to leave a smooth, flush concrete finish. Formwork to remain in place for minimum seven (7) days for cure, or longer until concrete has attained 75% of its specified 28 day strength.
 - .1 Apply approved curing compound as recommended by grout manufacturer as alternative to seven (7) day cure by formwork if 75% of concrete strength is achieved
- .5 Once forms have been removed edges of repair areas are to be grinded, hand patched, etc. as required to produce a smooth (form like) transition from the new patch surface to the existing concrete surfaces, as directed by Departmental Representative.
- .6 Grout that has sagged, debonded, is porous, honeycombed, or is cracked shall be replaced.

3.5 SLAB SURFACE - REPAIR OF SURFACE SCALING

- .1 The entire slab surface shall be shot-blasted to remove all deteriorated concrete, laitance and loose aggregate; removing a minimum of 6 mm of concrete surface.
- .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 with article **2.3 Rapid-Cure Surface Delamination Repair Materials**.
- .4 Thoroughly clean patch of dust and debris.
- .5 Prepare surfaces and place concrete mixture in strict accordance with CSA-A23.1
- .6 Surfaces to be board form finish, flush with existing surfaces, leaving no voids at patch edges.
- .7 Ensure curing in accordance with Manufacturer's recommendations.
- .8 Repair areas shall be shot-blasted clean, leaving the slab surface clean and free of all laitance acceptable for membrane application. Include second shot-blasting costs in unit cost of material as presented in unit price items.

3.6 CONCRETE MIXING AND PLACING

- .1 Concrete shall be machine mixed, unless otherwise stipulated by the Manufacturer. 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 re-handling.
- .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 re-tempered concrete shall be allowed.
- .6 Mix concrete in accordance with the Manufacturer's written instructions.

3.7 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.

3.8 CONCRETE CURING

- .1 Ensure Manufacturer's recommended curing conditions are maintained over the patch area when special patch materials are used. The more stringent curing conditions between the Manufacturer's recommendations and those outlined in this section will govern.
 - .1 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 to be in accordance with manufacturer's written requirement, but no less than one (1) day 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 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.
 - .2 Vertical repair patches are also to be wet cured, for the duration of the wet-curing period. 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 as necessary to prevent surface dusting of the concrete soffits.
 - .3 Use of chemical curing compounds shall not be permitted.
 - .4 Concrete shall be protected from harmful effects of heat, cold, running or surface water, and mechanical shock.
 - .5 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.

- .6 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.
- .7 Do not allow traffic onto patch until material has adequately cured to its specified 24-hour compressive strength.
- .2 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.

3.9 INSPECTION AND TESTING

- .1 To conform to CAN/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 grout cubes or cylinders for compressive strength.
 - .2 Review manufacturer's product data sheets submitted by the Contractor.
 - .3 Bond tests of concrete patches to existing concrete as requested by Departmental Representative.

- .4 Submit one copy of the test results directly to the Departmental Representative, the Departmental Representative, and the Contractor.
- .5 A minimum of one set of concrete grout cubes (9 cubes) or cylinders (4 cylinders) shall be taken for compressive tests for pre-packaged concrete patch materials
- .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. Strength test on approved grout shall consist of nine grout cubes with three cubes tested at seven (7) days and the remaining at 28 days. For cylinders, strength tests shall be undertaken on one cylinder each at 3 and 7 days with the remaining 2 tested at 28 days.
- .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 grout cubes or 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 or grout 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 If Contractor fails to notify testing agency in event of pour cancellation.

3.10 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.

3.11 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 75 mm 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.

3.12 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.

3.13 RECORD DRAWINGS

- .1 Maintain accurate records of materials used, 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