

1.0 GENERAL

1.1 Work Included

- .1 Provide all labour, material, equipment, and supervision necessary to prepare beam repair areas and place new concrete repair material.
- .2 Use of pre-packaged materials is to be in targeted repair locations at the Contractor's discretion.
- .3 All repairs to painted surfaces are to be cleaned and repainted after the concrete repairs have been completed and sufficient time for concrete curing has elapsed.

1.2 Repair Quantity Determination

- .1 Length and width shall be measured to the nearest 25 mm (1"). Depth, if applicable, shall be measured to the nearest 25 mm (1 inch).

1.3 References

- .1 All referenced Standards are latest editions referenced by the Building Code in the Place of the Work, or latest editions if not referenced by Code.
- .2 British Columbia Building Code
- .3 CSA A23.1/CSA A23.2 Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete
- .4 CSA A3000 Cementitious Materials Compendium
- .5 CSA S413 Parking Structures
- .6 ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete
- .7 ICRI 310.2R Selecting and Specifying Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.4 Performance Requirements

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

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

1.5 Submittals

- .1 Submit manufacturer's product specifications and data sheets for the following products:
 - .1 Vertical/Overhead patch materials
- .2 Submittals to be provided for review by the Consultant prior to placement or use of products as requested by the Consultant.
- .3 Do not commence placement of repair products until review is complete and proposed products and procedures are accepted by Consultant.
- .4 If requested by Consultant, provide a certificate signed by the Contractor and pre-packaged material manufacturer certifying the following:
 - .1 Surfaces to receive pre-packaged material were acceptable and satisfactory to receive the materials 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 written instructions and these Specifications.

1.6 Qualifications

- .1 Use only qualified concrete placers and finishers, with a minimum of two years' experience in similar work.

2.0 PRODUCTS

2.1 Materials

- .1 Portland Cement: 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 ASTM C260/C260M.
- .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: Type 10SF to CSA A3000.
- .9 Supplementary Cementing Material: To CSA A3000.
- .10 Superplasticizing Admixture: To CSA A3000.

2.2 Beam Delamination Repair Materials

- .1 Overhead patch materials shall be polymer-modified, cementitious, fast setting, and formulated especially for the repair of beam concrete surfaces.

- .2 Patch materials to have the following properties:

	<u>Description</u>	<u>Requirements</u>
.1	Compressive Strength (7 days)	30 MPa minimum
.2	Flexural Strength (7 days)	5 MPa minimum
.3	Slant/Shear Bond Strength (7 days)	5 MPa minimum
.4	Linear Shrinkage	0.10% maximum
.5	Rapid Chloride Permeability	less than 1,000 coulombs
.6	Thermally compatible with concrete substrate under all applicable service conditions.	

- .3 The patch materials listed below may conform to the specified properties and linear shrinkage requirements. Manufacturer's latest product data sheets for proposed patch materials shall demonstrate that the patch material conforms to the specified requirements. Where product data is incomplete, manufacturer is to provide supplementary independent test data that demonstrates conformance.

- .4 Patch Materials:

	<u>Product Name</u>	<u>Manufacturer</u>
.1	MasterEmaco S 440MC (form)	Master Builders Solutions
.2	MasterEmaco S 466CI (form, vertical only)	Master Builders Solutions
.3	MasterEmaco S 488CI	Master Builders Solutions
.4	MasterEmaco N 425	Master Builders Solutions

	<u>Product Name</u>	<u>Manufacturer</u>
.5	Planitop X	Mapei
.6	Planitop 23	Mapei
.7	Sika Top 122 PLUS (vertical only)	Sika
.8	Sika Top 123 PLUS	Sika

2.3 Admixtures

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

3.0 EXECUTION

3.1 Concrete Surface Preparation

- .1 All concrete surfaces to receive new concrete repair material shall have a minimum No. 6 CSP per ICRI 310.2R and be thoroughly abrasive-blast prior to concrete placement to remove laitance, debris, and loose aggregate.
- .2 Clean all existing concrete surfaces to receive new concrete of foreign material, dust, debris, grease, and oil as directed by Consultant. Emulsifiers shall be required for surfaces containing grease or oil.
- .3 Contractor to notify Consultant 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 stringent requirements of the Contract Specifications and manufacturer's written instructions.
- .2 The patch area shall be thoroughly wetted as required to achieve a saturated surface dry (SSD) state prior to placing concrete repair material.
- .3 Puddles of free water shall be blown from the patch area and the surface is to be permitted to dry to a saturated surface dry (SSD) state prior to application of cement slurry.
- .4 .

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- .5 Pre-wet filter fabric, burlap, or cotton mats shall be available on site prior to placement of concrete to allow for immediate placement overtop of new concrete patches after their initial set.
 - .6 Prepare pre-packaged concrete mix per manufacturer's specifications.
 - .7 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.
 - .8 Contractor to submit proposed aggregate extension mix design to the Consultant 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 are to be used for consolidation purposes only and are not to be used to an extent that causes segregation of the concrete.
 - .3 Internal vibrators shall conform to CSA A23.1 Clause 7.2.5.2 and Table 19: Internal Vibrators for Various Applications.
 - .4 Vibrators shall be inserted into concrete perpendicular to concrete surface.
 - .5 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 Finish concrete in accordance with CSA A23.1/A23.2. Initial finish shall be completed before any bleeding or free water is present on the surface of the concrete. Final finishing shall commence after the bleed water has disappeared and when the concrete has stiffened sufficiently to prevent the working of excess mortar to the surface. Do not add water to finish.
 - .12 Do not overwork concrete surface. Wood float finish is acceptable.

- .13 Do not use steel trowels with air-entrained concrete. For air-entrained concrete, the surface can be further levelled and consolidated with a magnesium bull float for larger repairs or a magnesium trowel for smaller repairs. One or more passes shall be made at suitable time intervals to obtain a level finish free of float marks. Do not work bleed water on the concrete surface into the concrete during finishing.
- .14 Tool crack control joints where indicated on Drawings or, if not shown on Drawings, per existing layout.
- .15 Cure in accordance with the more rigorous requirements of this Section and manufacturer's written instructions.
- .16 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 Consultant. Once forms have been removed, edges of through slab repair are to be ground, hand patched, etc. as required to produce smooth (form like) transition from new patch material to the existing slab.
- .17 Do not allow traffic on newly placed repair patches until 75% of the specified 28-day strength has been reached.

3.3 Concrete Placement – Vertical Surfaces (Gravity Grouting)

- .1 Ensure formwork is secure and free of debris.
- .2 Thoroughly wet the patch area and forms for a period of not less than twenty-four (24) hours prior to concrete placement.
- .3 Place new concrete into forms by gravity method and thoroughly consolidate concrete in forms using vibrators or other Consultant-approved method.
- .4 Remove all formwork and support brackets to leave a smooth and flush concrete finish after curing. Formwork to remain in place for seven days minimum for curing 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-day cure by formwork if 75% of concrete strength is achieved.

- .5 Edges of repair areas are to be ground, hand patched, etc. as required to produce a smooth (form-like) transition from the new patch surface to the existing slab to the approval of the Consultant once forms have been removed.
- .6 Concrete repair material that is sagged, debonded, porous, honeycombed, or cracked shall be replaced.

3.4 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 near as practicable to its final position to avoid re-handling.
- .4 Depositing shall be continuous throughout each division and the concrete shall be placed and worked so 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.

3.5 Compaction and Vibration

- .1 Concrete shall be consolidated by means of sufficient vibrators of adequate size operated by competent workers.
- .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.
- .4 Compaction and vibration is to eliminate all air and stone pockets that may cause honeycombing, pitting, or planes of weakness.

3.6 Concrete Curing

- .1 Ensure manufacturer's recommended curing conditions are maintained over the patch area. The more stringent curing conditions between the manufacturer's written instructions and those outlined in this section will govern unless otherwise agreed upon by the Consultant in writing.
- .2 Initiate surface concrete repair wet curing as soon as possible after the concrete has sufficiently set, and no later than 30 minutes after finishing.
 - .1 Minimum acceptable wet curing method on slab surfaces is installation of pre-saturated filter fabric, burlap, or cotton mats that are covered with soaker hoses and plastic sheeting. Overlap wet-curing mats 150 mm and ballast in place without marring the concrete surface.
 - .2 Wet curing procedures to be in accordance with manufacturer's written requirements, but shall be no less than a one-day period at a minimum temperature of 10°C. Water shall not be permitted to evaporate from the concrete surfaces at any time within the wet cure period.
 - .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 a duration of seven days by either:
 - .1 Maintaining formwork in place with form ties loosened and water applied to run down the inside form face after the concrete has hardened to keep the repair surfaces wet.
 - .2 Removing formwork from vertical surfaces and providing fog misting, light water spray, or application of wet burlap covered with polyethylene to keep the repair surfaces continually wet.
- .4 Exposed beam and slab soffit repairs require, as a minimum, misting with a water spray on a daily basis during the wet-curing period, or as often as is necessary to prevent surface dusting.
- .5 The use of chemical curing compounds is not permitted.
- .6 **Protect concrete from the harmful effects of heat, cold, running or surface water, and mechanical shock.**

- .7 **Do not place concrete when air temperature is below 10°C, or without implementing provisions to ensure proper curing of concrete when, in the opinion of the Consultant, there is a possibility of air temperature falling below 10°C. These provisions shall be reviewed by the Consultant and conform to the requirements of CSA A23.1.**
- .8 **Maintain concrete material and forms between 15°C and 32°C until concrete placement whenever the surrounding air is below 5°C. No frozen material or material containing ice shall be used. All existing concrete, reinforcement, forms, and ground that the concrete will contact is to be free from frost.**
- .9 **Maintain a curing temperature above 10°C for 10 days or longer to ensure proper concrete curing. Under no circumstances may dry heat be used. Provide means to humidify the air within the heated enclosure and ensure that moisture requirements for curing are maintained.**
- .10 The Consultant will have cause to not certify payment for repairs undertaken without adequate wet-curing procedures or that become surface dry during the specified curing period.

3.7 Inspection and Testing

- .1 Testing is to conform to CSA A23.2.
- .2 Inspection and testing to be conducted by a testing agency designated by the Owner. The Owner 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 **At the discretion of the Consultant, testing may include:**
 - .1 Preparation and testing of concrete grout cubes or cylinders for compressive strength.
 - .2 Review manufacturer product data sheets submitted by the Contractor.
 - .3 Bond testing of concrete repair patches to existing concrete where designated by the Consultant.
 - .4 Submission of test results to the Owner, the Consultant, and the Contractor.

- .5 A minimum of one set of concrete grout cubes (9 cubes) or cylinders (4 cylinders) shall be taken for compressive strength testing for of concrete patch material used each day unless otherwise directed by Consultant. Concrete test samples 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 A23.1 and A23.2. Strength test on approved grout shall consist of nine grout cubes with three cubes tested at seven days and the remainder tested at 28 days. For cylinders, strength tests shall be undertaken on one cylinder each at 3 and 7 days with the remaining two tested at 28 days.
- .6 The Contractor shall provide at no additional costs to the Owner:
 - .1 Samples of all material required for testing.
 - .2 Cooperation with the execution of concrete testing. which shall include protection against injury or loss of grout cubes or cylinders.
 - .3 Access for the testing agency 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, the testing agency may perform bond strength tests if requested by Consultant.
 - .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. The testing agency will drill through patches selected by Consultant.
 - .3 Failure to achieve a minimum tensile bond strength of 0.9 MPa shall constitute failure of patches.
 - .4 Contractor to fill all core holes with non-shrink cementitious grout upon completion of the tests.

.8 Contractor shall pay for costs of additional testing as follows:

.1 If Contractor fails to notify testing agency in event of pour cancellation.

3.8 Field Quality Control

.1 The Consultant 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 other techniques.

.3 Hollow sounds detected in repair area provide reason to suspect inadequate bonding. Contractor to core these areas to determine bonding adequacy where requested by the Consultant.

.4 Coring shall be through the new concrete and into the existing concrete. Core diameter shall be 75 mm, or as required by the Consultant. Length of cores shall be twice the core diameter or twice the thickness of new concrete, unless otherwise requested by the Consultant.

.5 Scanning is to be completed prior to coring to avoid coring through embedded reinforcing, conduit, or other embedded items.

.6 Cores will be visually inspected after removal and any further testing that is required will be determined by the Consultant.

.7 Contractor to patch core holes.

3.9 Rejection of Defective Work

.1 The Consultant shall have the right to order additional concrete testing of any portion of repairs in accordance with CSA A23.1 if previous testing demonstrates non-conformance with specified requirements. The testing agency shall be selected by the Consultant and shall deal directly with the Consultant. Payment for costs associated with the additional concrete testing will be at the Contractor's expense.

.2 Where it is the Consultant's opinion that material or workmanship fails to meet the specified requirements, the work shall be replaced or repaired to the approval of the Consultant at no additional cost to the Owner.

- .3 Bond failure between repair material and the existing concrete, or failure to meet compressive strength requirements based on compression testing of concrete cylinders, will result in drilling of additional core samples at the Contractor's expense. Failure of these additional samples will require the work to be replaced or repaired to the approval of the Consultant at no additional cost to the Owner.

END OF SECTION