

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 03 20 00 – Concrete Reinforcing.
- .2 Section 03 30 00 – Cast-In-Place Concrete.
- .3 Section 31 23 00 – Excavation and Fill.
- .4 General Notes on Structural Drawings

1.2 REFERENCES

- .5 Canadian Standards Association (CSA).
 - .1 CAN/CSA A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA O86-01 CONSOLIDATION (2006), Engineering Design in Wood.
 - .3 CSA O121-08, Douglas Fir Plywood.
 - .4 CSA O151-09, Canadian Softwood Plywood.
 - .5 CSA S269.1-1975 (R2003), Falsework for Construction Purposes.
 - .6 CAN/CSA S269.3-M92 (R2008), Concrete Formwork.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Formwork Materials: for concrete, use plywood and wood formwork materials to CAN/CSA O86, CSA O121, CSA O151, CAN/CSA S269.3.
- .2 Form Ties: use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than diameter in concrete surface.
- .3 Form Liner: Douglas Fir Plywood to CSA O121, Canadian Softwood Plywood to CSA O151, tongue and groove, square edge, 19 mm thickness.; plank material, orientated and similar in dimension to existing concrete pattern.
- .4 Form Release Agent: chemically active release agents containing compounds that react with free lime in concrete resulting in water insoluble soaps, preventing concrete from sticking to forms.
- .5 Falsework: to CSA S269.1.
- .6 Void Form: honeycomb type bio-degradable plastic wrapped cardboard 152 mm thick, treated to provide sufficient structural support for poured concrete until concrete cures.
- .7 Anchor Bolts: as approved by Contract Administrator.

PART 3 EXECUTION

3.1 ERECTION

- .1 Verify lines, levels and column or grid centre before proceeding with formwork and ensure dimensions agree with drawings.
- .2 Construct falsework in accordance with CSA S269.1.

- .3 Construct and erect formwork in accordance with CAN/CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CAN/CSA A23.1/A23.2.
- .4 Brace and tie together horizontally and vertically to maintain position, shape with adequate strength to resist horizontal, vertical loads from weight of wet concrete, reinforcing, form weight, wind, fluid pressure of concrete, weight of workers, other forces from equipment used in placing concrete.
- .5 Obtain Contract Administrator's permission before framing openings not indicated in concrete walls, slab, beams.
- .6 Set formwork level, plumb, as indicated on firm ground, or other acceptable support.
- .7 Coat formwork with form release agent, except formwork for surfaces to receive concrete topping, sealer, or other coating, and before reinforcement, anchors accessories, and other building items are installed.
- .8 Align form joints and make watertight. Keep form joints to minimum.
- .9 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .10 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections. Assure that all anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .11 Inside face of stairwell wall to be formed with planks to produce finish similar to existing concrete walls.
- .12 Clean formwork in accordance with CAN/CSA A23.1/A23.2 before placing concrete.
- .13 Install 152 mm thick, plastic wrapped cardboard void form continuously below grade beams, walls, pile caps, etc. where indicated.

3.2 REMOVAL AND RESHORING

- .14 Leave formwork in place for following minimum periods of time after placing concrete.
 - .1 Walls
 - .2 Concrete curing temperatures of:
 - .1 21 degrees C - 35 degrees C = 2 days
 - .2 16 degrees C - 21 degrees C = 3 days
 - .3 10 degrees C - 16 degrees C = 4 days
 - .3 Beam soffits, slabs, decks and other structural members: Concrete curing temperature of:
 - .1 21 degrees C - 35 degrees C = 14 days
 - .2 16 degrees C - 21 degrees C = 17 days
 - .3 10 degrees C - 16 degrees C = 21 days

- .15 Remove formwork when concrete has reached 75% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate re-shoring.
- .16 Provide all necessary re-shoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .17 Space re-shoring in each principal direction at not more than 3 metres apart.
- .18 Re-use formwork and falsework subject to requirements of CAN/CSA A23.1/A23.2.

END OF SECTION

PART 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 Submittals
- .2 Section 03 10 00 Concrete Forming and Accessories.
- .3 Section 03 30 00 Cast-in-Place Concrete.
- .4 General Notes on Structural Drawings

1.2 MEASUREMENT PROCEDURES

- .1 No measurement will be made under this Section.
 - .1 Include reinforcement costs in items of concrete work in Section 03 30 00 - Cast-In-Place Concrete.

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 SP-66-04, ACI Detailing Manual 2004.
 - .1 ACI 315-99, Details and Detailing of Concrete Reinforcement.
 - .2 ACI 315R-04, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.
 - .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A143/A143M-03, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .2 ASTM A185/A185M-05a, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - .3 ASTM A497/A497M-05a, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - .4 ASTM A775/A775M-04a, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - .3 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-A23.3-04, Design of Concrete Structures.
 - .3 CAN/CSA-G30.18-M92(R2002), Billet-Steel Bars for Concrete Reinforcement, A National Standard of Canada.
 - .4 CSA-G40.20/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles, A National Standard of Canada.
 - .6 CSA W186-M1990(R2002), Welding of Reinforcing Bars in Reinforced Concrete Construction.
 - .4 Reinforcing Steel Institute of Canada (RSIC)

- .1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittals.
- .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315.
- .3 Submit shop drawings including placing of reinforcement and indicate:
 - .1 Bar bending details.
 - .2 Lists.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Contract Administrator, with identifying code marks to permit correct placement without reference to structural drawings.
- .4 Detail lap lengths and bar development lengths to CSA-A23.3.
- .5 Quality Assurance: in accordance with Section 01 45 00 - Quality Control and as described in PART 2 - SOURCE QUALITY CONTROL.
 - .1 Mill Test Report: upon request, provide Contract Administrator with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Upon request submit in writing to Contract Administrator proposed source of reinforcement material to be supplied.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Place materials defined as hazardous or toxic in designated containers.

PART 2 Products

2.1 MATERIALS

- .1 Substitute different size bars only if permitted in writing by Contract Administrator.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CAN/CSA-G30.18.
- .4 Cold-drawn annealed steel wire ties: to ASTM A497/A497M.
- .5 Deformed steel wire for concrete reinforcement: to ASTM A497/A497M.
- .6 Welded steel wire fabric: to ASTM A185/A185M.
 - .1 Provide in flat sheets only
- .7 Welded deformed steel wire fabric: to ASTM A497/A497M.
 - .1 Provide in flat sheets only.
- .8 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .9 Mechanical splices: subject to approval of Contract Administrator.

- .10 Plain round bars: to CSA-G40.20/G40.21.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2, ACI 315 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain Contract Administrator 's approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of Contract Administrator, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 SOURCE QUALITY CONTROL

- .1 Upon request, provide Contract Administrator with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.
- .2 Upon request inform Contract Administrator of proposed source of material to be supplied.

PART 3 Execution

3.1 PREPARATION

- .1 Galvanizing to include chromate treatment.
 - .1 Duration of treatment to be 1 hour per 25 mm of bar diameter.
- .2 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A143/A143M.

3.2 FIELD BENDING

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by Contract Administrator.
- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

3.3 PLACING REINFORCEMENT

- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.
- .2 Prior to placing concrete, obtain Contract Administrator 's approval of reinforcing material and placement.
- .3 Ensure cover to reinforcement is maintained during concrete pour.

END OF SECTION

PART 1 GENERAL

PART 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 Submittals
- .2 Section 01 45 00 Quality Control
- .3 Section 03 10 00 Concrete Forming and Accessories.
- .4 Section 03 20 00 Concrete Reinforcing.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C260-01, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM C309-03, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .3 ASTM C330-04, Standard Specification for Lightweight Aggregates for Structural Concrete.
 - .4 ASTM C494/C494M-05, Standard Specification for Chemical Admixtures for Concrete.
 - .5 ASTM C1017/C1017M-03, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .6 ASTM D412-98a(2002)e1, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - .7 ASTM D624-00e1, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
 - .8 ASTM D1751-04, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .9 ASTM D1752-04a, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
 - .2 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1/A23.2-2004, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA A283-00(R2003), Qualification Code for Concrete Testing Laboratories.
 - .3 CAN/CSA-A3000-03, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.

1.3 ACRONYMS AND TYPES

- .1 Cement: hydraulic cement or blended hydraulic cement (XXb - where b denotes blended).
 - .1 Type GU or GUb - General use cement.
 - .2 Type MS or MSb - Moderate sulphate-resistant cement.
 - .3 Type MH or MHb - Moderate heat of hydration cement.
 - .4 Type HE or Heb - High early-strength cement.
 - .5 Type LH or LHb - Low heat of hydration cement.
 - .6 Type HS or HSb - High sulphate-resistant cement.
 - .7 Fly ash:
 - .1 Type F - with CaO content less than 8%.
 - .2 Type CI - with CaO content ranging from 8 to 20%.
 - .3 Type CH - with CaO greater than 20%.
- .2 GGBFS - Ground, granulated blast-furnace slag.

1.4 DESIGN REQUIREMENTS

- .1 Alternative 1 - Performance: in accordance with CSA-A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.

1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittals.
- .2 Submit testing results and reports for review by Contract Administrator and do not proceed without written approval when deviations from mix design or parameters are found.
- .3 Concrete pours: submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.
- .4 Concrete hauling time: submit for review by Contract Administrator deviations exceeding maximum allowable time of 120 minutes for concrete to be delivered to site of Work and discharged after batching.
- .5 Submit a copy of mix designs for each specified mix. Include granular gradation of materials to be used.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Acquire cement and aggregate from same source for all work.
- .3 Conform to CAN3-A23.1 when concreting during hot or cold weather.
 - .1 Take the following cold weather precautions:
 - .1 Ensure site preparations, special supplementary equipment in readiness while placing concrete in cold weather.
 - .2 Prepare as required for expected temperatures and type of work.
 - .3 Ensure concrete when deposited, not less than 16 degrees C, more than 32 degrees C when air temperature is below 5 degrees C, or the

probability existing of falling to 5 degrees C during placing, in the Contract Administrator's opinion.

- .2 When air temperature is below 5 degrees C or the probability exists of falling to 5 degrees C during the four days after placement, protect concrete with tarps and/or heat to maintain the temperatures indicated below.
- .3 For grade beams, and walls provide protection and/or heat for maintaining temperature of concrete surfaces not less the 18 degrees C for 72 hours.
- .4 For slabs, maintain concrete above 18°C for a minimum of 96 hours, keep from alternate freezing, thawing minimum fourteen days after placement.
- .5 For grade beams and slabs take an extra test cylinder and field cure under the same conditions as the poured element. Test sample prior to removing cold weather protection. Do not remove cold weather protection if the sample has not reached 60% of the specified strength.
- .6 Reduce concrete temperature gradually at end of specified protection period, at rate not exceeding 10°C per day until outside air temperature is reached.
- .7 Provide protection by adequate supplementary insulation, by enclosing concrete surfaces with raised tarpaulins or other approved methods.
- .8 Provide for introduction of heat into enclosure. Provide and maintain temperatures with heat for period specified.
- .9 Provide means to humidify air within enclosed space if dry type heat is used. Ensure combustion gases do not contact green concrete surfaces.
- .10 Vent heaters outside enclosed space. Do not use heaters which release products of combustion into enclosed space.
- .11 Do not place concrete on or against surface with temperature less than 4°C.
- .12 Protect slabs and subgrade from frost.
- .13 Protect floor slab, exposed concrete surfaces and surfaces to have applied finishes from grease, soil and other contaminants that affect appearance, impair topping, finish materials bond.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Concrete hauling time: maximum allowable time for concrete to be delivered to site of Work and discharged not to exceed 120 minutes after batching.
 - .1 Modifications to maximum time limit must be agreed to by Contract Administrator and concrete producer as described in CSA A23.1/A23.2.
 - .2 Deviations to be submitted for review by Contract Administrator.
- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .3 Waste Management and Disposal:
 - .1 Provide an appropriate area on the job site where concrete trucks can be safely washed. Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site.
 - .2 Unused admixtures and additive materials must not be disposed of into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.

- .3 Prevent admixtures and additive materials from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with inert, noncombustible material and remove for disposal. Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

PART 2 Products

2.1 MATERIALS

- .1 Cement: to CAN/CSA-A3001, Type GU. Type MS cement for piles.
- .2 Blended hydraulic cement: Type GUb to CAN/CSA-A3001.
- .3 Supplementary cementing materials: obtain approval from Contract Administrator prior to using supplementary cementing materials.
- .4 Water: to CSA-A23.1.
- .5 Aggregates: to CAN/CSA-A23.1/A23.2.
- .6 Admixtures:
 - .1 Air entraining admixture: to ASTM C260.
 - .2 Chemical admixture: to ASTM C494. Contract Administrator to approve accelerating or set retarding admixtures during cold and hot weather placing.
 - .3 Fly Ash: ASTM C618. Obtain approval from Contract Administrator prior to using fly ash.
- .7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA-A23.1/A23.2.
 - .1 Compressive strength: 17 MPa at 48 hours and 40MPa in 28 days.
- .8 Non premixed dry pack grout: composition of non metallic aggregate Portland cement with sufficient water for mixture to retain its shape when made into ball by hand and capable of developing compressive strength of 40 MPa at 28 days.
- .9 Premoulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751, 13 mm thick, tongue and groove profile.

2.2 MIXES

- .1 As noted on Drawings.

PART 3 Execution

3.1 PREPARATION

- .1 Obtain Contract Administrator 's review approval before placing concrete.
 - .1 Provide 36 hours notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:
 - .1 Development of cold joints not allowed.

- .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Use pencil vibrator or vibratory screed when placing all concrete.
- .6 Use elephant trunks or other accessories to ensure that concrete does not drop more than 1.5 metres.
- .7 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .8 Prior to placing of concrete obtain Contract Administrator 's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .9 Protect previous Work from staining.
- .10 Clean and remove stains prior to application for concrete finishes.
- .11 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .12 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
 - .1 Place steel dowels as indicated on drawings.
- .13 Do not place load upon new concrete until authorized by Contract Administrator.
- .14 Placing Grout: grout under base plates using procedures in accordance with manufacturer's instructions. Place grout to cover steel shims left in place. Ensure full contact with base plate and concrete. Modify consistency of grout to ensure full penetration of grout. Ensure final specified strengths are achieved.

3.2 CONSTRUCTION

- .1 Do cast-in-place concrete work in accordance with CSA-A23.1/A23.2.
- .2 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by Contract Administrator.
 - .2 Where approved by Contract Administrator, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by Contract Administrator.
 - .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Contract Administrator before placing of concrete.
 - .5 Check locations and sizes of sleeves and openings shown on drawings.
 - .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .3 Anchor bolts:
 - .1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
 - .2 Protect anchor bolt holes from water accumulations, snow and ice build-ups.

- .3 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.
- .4 Drainage holes and weep holes:
 - .1 Form weep holes and drainage holes in accordance with Section 03 10 00 - Concrete Forming and Accessories. If wood forms are used, remove them after concrete has set.
 - .2 Install weep hole tubes and drains as indicated.
- .5 Grout under base plates using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.
- .6 Finishing and curing:
 - .1 Finish concrete in accordance with CSA-A23.1/A23.2.
 - .2 Use procedures as reviewed by Contract Administrator or those noted in CSA-A23.1/A23.2 to remove excess bleed water. Ensure surface is not damaged.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces. Provide written declaration that compounds used are compatible.
 - .4 Broom finish surface of exterior slabs.
 - .5 Provide concrete surfaces to be left exposed with smooth rub finish.
 - .6 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radius edges unless otherwise indicated.
 - .7 Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
 - .8 Spray water over floor slab areas and provide burlap over floor slab to maintain continuously wet for minimum of 7 days.
 - .9 Cure concrete in accordance with CAN/CSA-A23.1.
- .7 Patching:
 - .1 Allow Contract Administrator to inspect concrete surfaces immediately after removal of forms.
 - .2 Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Contract Administrator upon discovery.
 - .3 Patch imperfections as directed, at no cost to the Contract Administrator.
- .8 Defective Concrete:
 - .1 Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
 - .2 Repair or replacement of defective concrete will be determined by the Contract Administrator.
 - .3 Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Contract Administrator for each individual area.
- .9 Toppings:
 - .1 In pouring base course, make allowance for monolithic topping thickness.
 - .2 Apply cement/sand grout to base course in accordance with CSA-A23.1/A23.2.
 - .3 Place monolithic topping in accordance with CSA-A23.1/A23.2 and topping manufacturer's recommendations.

- .4 Ensure that joints in topping are of same material as those in base course. Also ensure that their locations precisely match those in base course. Provide reinforcing mesh as indicated on Drawings.
- .10 Waterstops:
 - .1 Install waterstops to provide continuous water seal.
 - .2 Do not distort or pierce waterstop in way as to hamper performance. Do not displace reinforcement when installing waterstops.
 - .3 Use equipment to manufacturer's requirements to field splice waterstops.
 - .4 Tie waterstops rigidly in place.
 - .5 Use only straight heat sealed butt joints in field.
 - .6 Use factory welded corners and intersections unless otherwise approved by Contract Administrator.
- .11 Joint Fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Contract Administrator.
 - .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
 - .3 Locate and form construction and expansion joints as indicated.
 - .4 Install joint filler.
 - .5 Use 13 mm thick joint filler to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to top of slab surface unless indicated otherwise.

3.3 SURFACE TOLERANCE

- .1 Concrete tolerance in accordance with CSA-A23.1/A23.2 straightedge method.

3.4 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by Contract Administrator for review in accordance with CSA-A23.1/A23.2.
 - .1 Ensure testing laboratory is certified in accordance with CSA A283.
- .2 Cost of tests will be paid for by section 012113
- .3 Contract Administrator will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .4 Non-Destructive Methods for Testing Concrete: in accordance with CSA-A23.1/A23.2.
- .5 Inspection or testing by Contract Administrator will not augment or replace Contractor quality control nor relieve Contractor of their contractual responsibility.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 The care that is exercised during the removal and preparation phases of concrete repairs can be the most important factor in determining the longevity of the repair, regardless of the material or technique used. This Section covers the removal of deteriorated concrete and surface preparation for the repair of deteriorated concrete resulting from reinforcing steel corrosion and is applicable to horizontal, vertical, and overhead repairs.
- .2 All delaminated or deteriorated concrete must be removed down to sound concrete. The reinforcing may have to be exposed at these locations by removing additional concrete, if there is any sign of corrosion. All concrete and exposed reinforcing shall be cleaned of all corrosion by mechanical means.

1.2 RELATED SECTIONS

- .1 Section 03 20 00 – Concrete Reinforcing.
- .2 Section 03 92 11 – Top Surface Repairs with Rapid Setting Mortar
- .3 Section 03 92 20 – Top Surface Scaling Repairs
- .4 Section 03 93 10 – Hand Patching
- .5 Section 03 93 20 – Pressure Grouting
- .6 Section 03 93 30 – Form and Pour

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 ACI 546-04, Concrete Repair Guide.
 - .2 ACI RAP-5, Surface Repair Using Form-and-Pump Techniques.
 - .3 ACI RAP-7, Spall Repair of Horizontal Concrete Surfaces.
 - .4 ACI RAP-3, Spall Repair by Low-Pressure Spraying.
 - .5 ACI RAP-4, Surface Repair Using Form-and-Pour Techniques.
 - .6 ACI RAP-6, Vertical and Overhead Spall Repair by Hand Application.
 - .7 ACI RAP-9, Spall Repair by the Preplaced Aggregate Method.
- .2 Canadian Standards Association (CSA)
 - .1 CSA- S448.1-10, Repair of Reinforced Concrete in Buildings.
- .3 International Concrete Repair Institute (ICRI)
 - .1 ICRI concrete Repair Terminology (2010 Edition).

- .2 ICRI Guideline No. 120.1–2009, Guidelines and Recommendations for Safety in the Concrete Repair Industry.
- .3 ICRI Guideline No. 130.1R–2009, Guide for Methods of Measurement and Contract Types for Concrete Repair Work (formerly No. 03735).
- .4 ICRI Guideline No. 310.1R–2008, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion (formerly No. 03730).
- .5 ICRI Guideline No. 310.2–1997, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays (formerly No. 03732).

1.4 MEASUREMENT PROCEDURES

- .1 Concrete areas of repair will be identified and quantified via soundings compelled by the Contract Administrator in the presence of and with the assistance of the Contractor. The areas will then be measured and agreed upon by the Contractor and Contract Administrator prior to commencement of work.
- .2 Refer to applicable Sections for measurement procedures for each type of repair.

1.5 DEFINITIONS

- .1 Delamination: A separation along a plane parallel to a surface as in the separation of a coating from a substrate or the layers of a coating from each other, or in the case of a concrete slab, a horizontal splitting, cracking, or separation of a slab in a plane roughly parallel to, and generally near, the upper surface.
- .2 Laitance: A weak layer of cement and aggregate fines on a concrete surface that is usually caused by an overwet mixture, overworking the mixture or excessive finishing, underwater concrete placement, or combinations thereof.
- .3 Sounding: A technique to evaluate the condition of hardened concrete by striking the surface with a hammer; sound concrete will exhibit a clear ringing sound, whereas dull or hollow sounds indicate delaminated areas.
- .4 Spall: A fragment, usually in the shape of a flake, detached from a larger mass by a blow, by the action of weather, by pressure, or by expansion within the larger mass; a small spall involves a roughly circular depression not greater than 120 mm in depth and 150 mm in any dimension; a large spall, may be roughly circular or oval or in some cases elongated, is more than 20 mm in depth and 150 mm in greatest dimension
- .5 Substrate: The layer immediately under a layer of different material to which it is typically bonded; an existing concrete surface that receives an overlay, partial-depth repair, protective coating, or some other maintenance or repair procedure.
- .6 Surface Preparation: The process whereby a method or combination of methods is used to remove deteriorated or contaminated concrete and roughen and clean a substrate to enhance bond of a repair material or protective coating.
- .7 Surface Profile: The topographic contour of the exposed surface of a material or substrate.

1.6 QUALITY ASSURANCE

- .1 Contractor Qualifications:
 - .1 Minimum of 5 years experience in the repair and restoration of concrete structures.
 - .2 Provide minimum 5 examples of local projects demonstrating successful performance concrete repairs of similar size and complexity to specified Work within the last 3 years.
 - .3 Site Superintendent to have a minimum of 5 years experience exhibiting successful performance in concrete restoration projects. Provide references upon request.
 - .4 Ensure all personnel involved with concrete restoration are adequately trained and familiar with the requirements of this Section.
- .2 Field Mock-ups:
 - .1 Upon request, complete a field mock-up for each type of repair. Locations to be site determined.
 - .2 Field mock-up shall be a minimum of 2 sq.ft. and incorporate all aspects of the concrete surface preparation described in this Section. Trial repairs areas shall be chosen to include exposure of embedded reinforcing steel.
 - .3 Field mock-up areas shall be used as a standard against which subsequent work shall be judged.

Part 2 Products

2.1 EQUIPMENT

- .1 Electric or pneumatic chipping hammers are to be used for demolition within the following limits:
 - .1 Initial bulk removal of delaminated concrete above corroded reinforcing steel: maximum 25 lb. electric or pneumatic chipping hammers.
 - .2 Final removal and undercutting of reinforcing steel: maximum 15 lb. electric chipping hammers.
 - .3 Bulk removal of full depth repairs: electric or pneumatic jack hammers with weight ratings above 30 lbs. may be used upon approval by Contract Administrator.
 - .4 Chisel-type blades are to be used for removal only. Do not use pointed chisels for removal.
- .2 Sandblast equipment shall consist of:
 - .1 Air compressor of sufficient capacity to drive the equipment and blast media selected.
 - .2 Blast media hopper (meters the media into the air stream passing through the hose and nozzle).
 - .3 Moisture and oil separators to insure clean, dry air supply.
 - .4 Blast nozzle and hose.

- .5 Materials. The blast medium consistent with equipment, site conditions, and capable of obtaining specified surface profile.
- .3 High pressure waterblast: capable of maintaining a sustained pressure of not less than 4,000 psi.

Part 3 Execution

3.1 EXAMINATION

- .1 The location number and extent of repairs shown on Drawings are indicative only. Repairs areas will be identified on-site by the Contract Administrator in the presence of and with the assistance of the Contractor. The approximately periphery of the repair will be marked on the surface of the member and the location and extent recorded on drawings
- .2 Allow time in the Schedule for survey and inspection work carried out by the Contract Administrator ahead of repairs. Provide sufficient safe access to enable review of all areas designated for repairs.
- .3 The Contractor shall make available as required throughout the Contract labour to carry out the following under the direction of Contract Administrator:
 - .1 Identification of repairs.
 - .2 Sample chipping and/or drilling.
 - .3 Operators for access equipment.
- .4 The Contractor shall make available as required throughout the Contract equipment for the use of the Contract Administrator:
 - .1 Marking paint and chalk.
 - .2 Hammer and chain for sounding surveys.
 - .3 Tape measure.

3.2 PREPARATION

- .1 All necessary measures shall be taken to provide protection to the general public, occupants of the building.
- .2 Remove or protect all surface attachments (e.g. signs, notices, electrical fittings) from the areas to be repaired or from positions that obstruct access or which may be damaged from Work.
- .3 Carefully store items removed during the course of the works. Reinstall when restoration work is complete.
- .4 The Contractor shall make good or rectify any damage caused as a result of insufficient protection.
- .5 Provide temporary access required to facilitate Work.

3.3 CONCRETE DELAMINATION REMOVAL

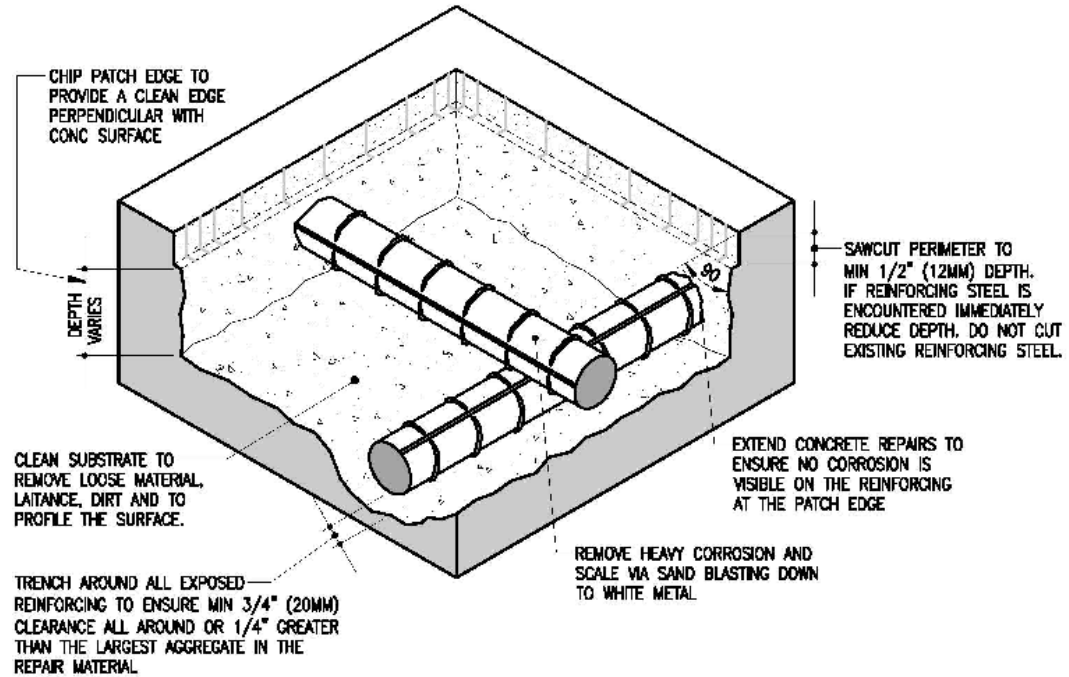
- .1 Refer also to Figure 1 in this Section.
- .2 Remove all loose and or delaminated concrete above corroded reinforcing steel.
- .3 Do not operate hammers or mechanical chipping tools at an angle in excess of 45° measured from the surface of the slab.
- .4 Use chipping to extend concrete removal along reinforcing bars and ensure bars are completely free of corrosion and well bonded to the surrounding concrete. Notify Contract Administrator of increases in areas.
- .5 Where the bond between existing concrete and reinforcing steel or mesh has been destroyed (either by the concrete's deterioration or corrosion of the reinforcing steel) or if the chipping operation has caused more than 1/3 the periphery of a bar to be exposed for a distance of 6 inches (150 mm) or more, the concrete adjacent to the bar shall be removed by maximum 15 lb. electric chipping hammers to provide sufficient clearance between the reinforcement and concrete.
 - .1 Provide a minimum 3/4 inches (20 mm) clearance, or 1/4 inch (6 mm) larger than the largest aggregate in the repair material, whichever is greater.
- .6 If non-corroded reinforcing steel is exposed, do not damage the bar's bond to the surrounding concrete. If bond between the bar and concrete is destroyed, exposing the bar will be required.
- .7 The perimeter of the areas marked as delaminated are to be saw cut to a depth of 1/2 inch (12 mm). Feather edging is not permitted. If reinforcing steel is encountered, the saw depth must be immediately reduced as required. Check depth of the cut regularly.
- .8 Ensure sawcut encompasses the boundaries of corrosion that have been established.
- .9 Ensure the entire area within the saw cut is removed to a depth consistent with the type of repair and repair material specified in other Sections.
- .10 Chip patch edges to provide a clean vertical edge along the patch perimeter to the required minimum depth.
- .11 Conduct soundings to determine if any further unsound or delaminated concrete is present, which must be removed.
- .12 After all delaminated, unsound, or loose material is removed, the Contractor shall request an inspection from the Contract Administrator. This inspection is to be completed in the presence of the Contractor and if any further Work is required, the Contractor is to complete it immediately. The purpose of this inspection is to provide assurance to the Contract Administrator that all loose material has been removed and the substrate is sound.

3.4 SURFACE PREPARATION OF CONCRETE AND REINFORCING STEEL

- .1 Refer also to Figure 1 in this Section.

- .2 Within 24 hours prior to infilling, sandblast the substrate to remove loose and deteriorated concrete, laitance, dust, dirt, oil, and any other material that could interfere with the bond of the new concrete. Provide a uniform surface profile of ICRI-CSP-5 or better. Sample surfaces are available for inspection in the Contract Administrator's office. These samples will be used as the standard of acceptance.
- .3 Surface preparation applies equally to any horizontal or vertical concrete surfaces to which the concrete is to bond.
- .4 Exposed reinforcing steel to be cleaned to near white metal and totally free of rust for the full circumference of the bar.
- .5 Secure any reinforcement which is loose by tying to other secured bars or by other methods approved by Contract Administrator.
- .6 Vacuum clean surface and/or air blast with oil free compressed air to remove residue and spent media created by surface preparation.
- .7 Maintain substrate in a clean condition using polyethylene film until the patch material is ready to be placed.
- .8 After all surface preparation is complete the Contractor shall request an inspection from the Contract Administrator to review the existing reinforcing steel. The purpose of this inspection is to provide assurance that all heavy corrosion and scale is removed from the bar. At that time, the Contract Administrator will review the condition of the reinforcing steel and determine if the addition of supplemental reinforcing steel will be required. At locations identified by the Contract Administrator, provide supplemental reinforcing steel to Section 03 20 00.
- .9 Final cleaning of the concrete substrate shall consist of a high pressure waterblast substrate at minimum 4,000 psi to remove any residual dust and dirt.

Figure 1: Surface Preparation for Concrete Delamination Repair



3.5 FIELD QUALITY CONTROL

- .1 Coordinate site work and inspections with Contract Administrator. Provide minimum 24 hours notice prior to each phase of the work.
- .2 Contract Administrator inspection to be completed at the following times:
 - .1 Prior to demolition to identify and quantify repair locations and types.
 - .2 Following initial demolition to confirm all loose, deteriorated, or unsound concrete has been removed from the substrate.
 - .3 Following concrete substrate preparation to review concrete surface profile and condition of reinforcing steel.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This section covers the removal and replacement of scaled surface areas the structural deck to provide a smooth surface for installation of the membrane.
- .2 The scaling will be removed with a bush hammer and subsequently infilled with thin patching compound. Topping shall be removed and replaced using the same material, extended with aggregate.

1.2 RELATED SECTIONS

- .1 Section 03 91 10 – Surface Preparation for Concrete Delamination Repair.

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 ACI 546-04, Concrete Repair Guide.
- .2 Canadian Standards Association (CSA)
 - .1 CSA- S448.1-10, Repair of Reinforced Concrete in Buildings.
- .3 International Concrete Repair Institute
 - .1 ICRI concrete Repair Terminology (2010 Edition).
 - .2 ICRI Guideline No. 120.1–2009, Guidelines and Recommendations for Safety in the Concrete Repair Industry.
 - .3 ICRI Guideline No. 130.1R–2009, Guide for Methods of Measurement and Contract Types for Concrete Repair Work (formerly No. 03735).
 - .4 ICRI Guideline No. 320.3-2007, Guideline for Inorganic Repair Material Data Sheet Protocol (formerly No. 03740).

1.4 UNIT PRICES

- .1 Scaling repairs completed under this Section will be measured in square feet for repair depths of up to 1 inch. Unit prices must include all supervision, labour and materials, and equipment.
- .2 Minimum payment for repair areas will be one square foot.
- .3 The repair areas will be identified by the Contract Administrator on-site by a chain drag sounding survey to be completed in the presence of and with the assistance of the Contractor. The areas will then be measured and agreed upon by the Contractor and Contract Administrator prior to commencement of work. These measurements will form the basis of payment for the area.
- .4 The Contractor is to note that if the Contractor increases the area of the repair over that originally measured without consultation with the Contract Administrator, the Contractor will not be paid for the increased area.

1.5 QUALITY ASSURANCE

- .1 Contractor Qualifications:
 - .1 Minimum of 5 years experience in application of specified (or similar) products on projects of similar size and scope.
 - .2 Successful completion of a minimum of 5 projects of similar size and complexity to specified Work within the last 3 years.
- .2 Field Mock-up:
 - .1 Upon request, install field mock-up at Project site or pre-selected area of building or location approved by Contract Administrator. Install material in accordance with this Section.
 - .2 Field mock-up will be standard for judging workmanship on remainder of Project.
 - .3 Manufacturer's representative or designated representative will review technical aspects; surface preparation, repair, and workmanship.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .2 Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures.
- .3 Keep materials in manufacturer's original, unopened containers and packaging until installation.
- .4 Protect materials during storage, handling, and application to prevent contamination or damage.

1.7 PROJECT CONDITIONS

- .1 Environmental Requirements:
 - .1 Ensure that substrate surface and ambient air temperature are minimum of 4°C and rising at application time and remain above 4°C for at least 24 hours after application. Ensure that frost or frozen surfaces are thawed and dry.
 - .2 Ensure that substrate surface and ambient air temperature are below of 32°C and remain below 32°C for at least 8 hours after application.
 - .3 Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain temperature and conditions specified before proceeding with application.

Part 2 Products

2.1 MATERIALS

- .1 Horizontal Repair Mortar: Two-component, screedable, shrinkage-compensated, portland-cement-based repair mortar, with integral corrosion inhibitor with a minimum application thickness of 1/4 inch (6 mm).

- .1 Properties:
 - .1 Unit Weight, ASTM C 185: 124 to 132 pcf (1,986 to 2,115 kg/m³).
 - .2 Working Time, 70 degrees F (21 degrees C): Greater than 30 minutes.
 - .3 Setting Time, ASTM C 266:
 - .1 Standard Application Temperature, 70 degrees F (21 degrees C):
 - .1 Initial Setting Time: 40 to 90 minutes.
 - .2 Final Setting Time: Less than 120 minutes.
 - .2 Maximum Application Temperature, 90 degrees F (32 degrees C):
 - .1 Initial Setting Time: 25 to 50 minutes.
 - .2 Final Setting Time: Less than 60 minutes.
 - .3 Minimum Application Temperature, 50 degrees F (10 degrees C):
 - .1 Initial Setting Time: 100 to 150 minutes.
 - .2 Final Setting Time: Less than 170 minutes.
 - .4 Compressive Strength, ASTM C 109, 73 degrees F (23 degrees C):
 - .1 3 Hours: Greater than 1,500 psi (10.3 MPa).
 - .2 1 Day: Greater than 3,000 psi (20.7 MPa).
 - .3 7 Days: Greater than 4,000 psi (27.6 MPa).
 - .4 28 Days: Greater than 5,000 psi (34.5 MPa).
 - .5 Drying Shrinkage, ASTM C 157, Modified, 28 Days: Less than 500 percent (μ strain).
 - .6 Rapid Chloride Permeability, ASTM C 1202/AASHTO T 277: Very low range, coulombs.
 - .7 Static Modulus of Elasticity, ASTM C 469, 28 Days: 3.2×10^6 psi (22.1 GPa).
 - .8 Salt Scaling Resistance, ASTM C 672, 50 Cycles, Rating: 1.
 - .9 Coefficient of Thermal Expansion, CRD C 39: 8.1×10^{-6} in/in/degree F (1.46×10^{-5} m/m/degree C).
 - .10 Freezing and Thawing Resistance, ASTM C 666, Procedure A:
 - .1 Average Durability Factor, 300 Cycles: Greater than 85.
 - .11 Cracking Resistance, ASTM C 1581, plots of steel ring strain versus specimen age for each test specimen:
 - .1 Average Initial Strain: 4.45.
 - .2 Average Maximum Strain: 39.91.
 - .3 Average Age at Cracking: Greater than 60 days.
 - .12 Compressive Creep, ASTM C 512, Average Creep Strain:
 - .1 7 Days: 0.053 μ strain/psi.
 - .2 28 Days: 0.075 μ strain/psi.
 - .13 Direct Tensile Strength, CRD C 164, 2-inch by 4-inch specimens, Average Tensile Strength:
 - .1 1 Day: 350 psi.
 - .2 7 Days: 400 psi.

- .3 28 Days: 500 psi.
- .14 Bond Strength, ASTM C 882, Modified per ASTM C 928, 3-inch by 6-inch slant-shear specimens, Average Slant-Shear Bond Strength:
 - .1 1 Day: Greater than 1,000 psi.
 - .2 7 Days: Greater than 1,500 psi.
 - .3 28 Days: Greater than 2,000 psi.
- .15 VOC Content: 0 lbs per gal (0 g/L), less water and exempt solvents.
- .2 Acceptable Product: ZERO-C Horizontal Extended Mortar by BASF Building Systems.
 - .1 Components:
 - .1 ZERO-C Horizontal Liquid.
 - .2 ZERO-C Horizontal Mortar.

2.2 ACCESSORIES

- .1 Evaporation retardant: Confilm by BASF Building Systems at a minimum application rate of 4.9 m²/L.
- .2 Cure and sealing compound: to ASTM C309, Type 1. Acceptable product(s):
 - .1 Florseal WB by Sika Canada Inc. at a minimum application rate of 4.9 m²/L.
 - .2 Kure-N-Seal WB by BASF Building Systems at a minimum application rate of 4.9 m²/L.

Part 3 Execution

3.1 SCALING REMOVAL PROCEDURES

- .1 The Contract Administrator will mark out the perimeter of the scaled or debonded areas, which are to be removed as specified herein.
- .2 The Contractor must saw-cut the perimeter of the scaled repair area to 1/4 inch. Removal of the scaled material shall be accomplished by the use of a short stroke electric chipping hammer with a sharp bush hammer bit to remove the surface scaling within the marked-out areas.
- .3 Minimum depth of removal will be 1/4 inch, and maximum depth will be 1 inch for scaling repairs.
- .4 Once the areas have been bush hammered, the Contractor must chain drag all areas to determine if any further unsound material is present, which must be removed.
- .5 Once the areas are determined by the Contractor to be sound, request a final inspection from the Contract Administrator. This inspection shall be done in the presence of the Contractor, who shall complete any further work at the time of the inspection.
- .6 Within 24 hours prior to infilling, sandblast and/or shotblast the substrate to remove loose and deteriorated concrete, laitance, dust, dirt, oil, and any other material that could interfere with the bond of the new concrete. Provide a uniform surface profile of ICRI-

CSP-5 or better. Sample surfaces are available for inspection in the Contract Administrator's office. These samples will be used as the standard of acceptance.

- .7 Vacuum clean surface and/or air blast with oil free compressed air to remove residue and spent media created by surface preparation.
- .8 Maintain substrate in a clean condition using polyethylene film until the overlay is ready to be placed.
- .9 Waterblast substrate at minimum 4,000 psi to remove any residual dust and dirt. Maintain substrate in a saturated condition for a period of not less than two (2) hours prior to concrete placement. If the concrete surface becomes wet and subsequently dries, the surface preparation and cleaning procedure must be repeated.

3.2 INFILL PROCEDURE

- .1 Obtain Contract Administrator's approval before placing repair material. Provide minimum 24 hours notice.
- .2 Maintain the substrate in a saturated surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.
- .3 Mixing of horizontal mortar]
 - .1 Mix materials in accordance with manufacturer's instructions.
 - .2 Precondition components to 16°C to 27° C for 24 hours before mixing.
 - .3 Ensure repair mortar is thoroughly mixed.
 - .4 Do not use free-fall mixers.
 - .5 Never mix partial bags.
- .4 Bonding Slurry Application:
 - .1 Apply the bonding slurry consisting of neat rapid-setting mortar to a saturated surface dry (SSD) substrate with no standing water and dry to the touch. A SSD substrate typically exhibits a colour change of dark grey to light grey. Remove standing water by vacuuming.
 - .2 Scrub plastic slurry into substrate with stiff bristled broom or brush to produce a uniform thickness of 1/8" over entire area.
 - .3 Place repair material while the bonding slurry is still plastic. Do not apply more slurry than can be covered with concrete before it dries. Do not retemper. If the bond slurry dries prior to placement of the concrete, removal of the dried slurry will be required. The concrete substrate will then be cleaned and prepared in accordance with the requirements described in the previous sections.
- .5 Immediately place repair material, into the prepared patch area from one side to the other. Work the repair material firmly into the bottom and sides of the patch, and underneath reinforcing steel, to assure good bond.
- .6 Ensure that rate of placing is sufficient to complete proposed placing, finishing and curing operations within scheduled time. Limit batch sizes as required if placing procedures are slower than anticipated.

- .7 Continuously consolidate and finish to [matching][specified] elevations, ensuring patch thickness and required elevations are maintained.
- .8 Ensure reinforcement, floor drains, inserts, etc. are not disturbed during concrete placement.

3.3 FINISHING

- .1 Following consolidation and screeding, the surface shall be immediately bull-floated to close and smooth the surface.
- .2 Surface to receive a smooth finish free of ridges and trowel marks.
- .3 Apply evaporation retardant at manufacturers recommended coverage rate immediately following final finishing. Do not apply evaporation retardant during any finishing operation nor should it be worked into the surface.
- .4 Protect freshly placed repair mortar from exposure to dust, debris and precipitation.

3.4 CURING

- .1 Concrete repairs to be cured for a minimum of 3 days at 10°C.
- .2 Immediately after final finishing, apply evaporation retardant to prevent drying shrinkage until the concrete has enough strength to support the placement of the wet burlap.
- .3 Burlap to be thoroughly presoaked by immersing it in water for a period of at least 24 hours immediately prior to placement.
- .4 Commence wet curing as soon as the surface will support the weight of the wetted burlap without deformation. Burlap to be applied in one layer with strips overlapping at least 3" and be securely held in place without marring the concrete surface.
- .5 Wet curing with burlap and water must be maintained throughout entire curing period.
- .6 Workers shall not be allowed on the overlay for 12 hours after placement. Do not place load upon new concrete until curing period is over.

3.5 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Contract Administrator in accordance with CSA-A23.1 and Section 01 45 00 - Quality Control and as described herein.
- .2 The Contractor will pay for costs of tests via the testing cash allowance as per Section 01 2 10 - Allowances.
- .3 Not less than one test per 50 square feet of patching material placed and not less than one test for each day of placement.
 - .1 Test samples to be prepared by a CSA certified laboratory in accordance with ASTM C109.

- .4 Bond tests will be completed at the discretion of the Contract Administrator.
 - .1 Infilling of the core hole will be the responsibility of the General Contractor. Unless otherwise directed by the Contract Administrator, repair in accordance with this Section.
- .5 Testing agency to submit copies of concrete test reports directly to Contract Administrator.
- .6 Inspection or testing by Contract Administrator will not augment or replace Contractor quality control nor relieve contractual responsibility.

3.6 DEFECTIVE CONCRETE

- .1 Defective concrete: bond strengths below minimum specified value, cracking, spalling, scaling and concrete not conforming to required lines, details, dimensions, tolerances, finishes or specified requirements.
- .2 Repair or replacement of defective concrete will be determined by the Contract Administrator, based on the specifications and the above guidelines.
- .3 Do not patch, fill, touch up, repair or replace exposed concrete except upon express direction of Contract Administrator for each individual use.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 The top surface of slabs and beam exhibiting extensive spalling and/or delamination are to be repaired by mechanical removal of the deteriorated concrete and infilling with a rapid-setting mortar.
- .2 All spalling and/or delaminated concrete must be removed down to sound concrete in accordance with Section 03 91 10.

1.2 RELATED SECTIONS

- .1 Section 03 10 00 – Concrete Forming and Accessories.
- .2 Section 03 20 00 – Concrete Reinforcing.
- .3 Section 03 91 10 – Surface Preparation for Concrete Delamination Repair.

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 ACI 546-04, Concrete Repair Guide.
 - .2 ACI RAP-7, Spall Repair of Horizontal Concrete Surfaces.
- .2 Canadian Standards Association (CSA)
 - .1 CSA- S448.1-10, Repair of Reinforced Concrete in Buildings.
- .3 International Concrete Repair Institute
 - .1 ICRI concrete Repair Terminology (2010 Edition).
 - .2 ICRI Guideline No. 120.1–2009, Guidelines and Recommendations for Safety in the Concrete Repair Industry.
 - .3 ICRI Guideline No. 130.1R–2009, Guide for Methods of Measurement and Contract Types for Concrete Repair Work (formerly No. 03735).
 - .4 ICRI Guideline No. 320.3-2007, Guideline for Inorganic Repair Material Data Sheet Protocol (formerly No. 03740).

1.4 MEASUREMENT PROCEDURES

- .1 The repair areas will be identified by the Contract Administrator on-site by a chain drag sounding survey which will be completed in the presence of, and with the assistance of the Contractor. The areas will then be measured and agreed upon by the Contractor and Contract Administrator prior to commencement of work. These measurements will form the basis of payment for the area.
- .2 Unit prices must include all supervision, labour and materials, and equipment.
- .3 The unit price submitted will apply to removal depths of up to 2 inches and at no point less than 1 inches in depth into the structural slab. A second unit price must also be

submitted which will apply to removal depths of up to a 4 inch depth and at no point less than 2 inches in depth.

- .4 Minimum payment for repair areas will be 1 square foot.
- .5 The Contractor is to note that if the area of the repair is increased over that originally measured without consultation with the Contract Administrator, then the Contractor will not be paid for the increased area.

1.5 QUALITY ASSURANCE

- .1 Contractor Qualifications:
 - .1 Minimum of 5 years experience in application of specified (or similar) products on projects of similar size and scope.
 - .2 Successful completion of a minimum of 5 projects of similar size and complexity to specified Work within the last 3 years.
- .2 Field Mock-up:
 - .1 Upon request, install field mock-up at Project site or pre-selected area of building or location approved by Contract Administrator. Install material in accordance with this Section.
 - .2 Field mock-up will be standard for judging workmanship on remainder of Project.
 - .3 Manufacturer's representative or designated representative will review technical aspects; surface preparation, repair, and workmanship.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .2 Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures.
- .3 Keep materials in manufacturer's original, unopened containers and packaging until installation.
- .4 Protect materials during storage, handling, and application to prevent contamination or damage.

1.7 PROJECT CONDITIONS

- .1 Environmental Requirements:
 - .1 Ensure that substrate surface and ambient air temperature are minimum of 4°C and rising at application time and remain above 4°C for at least 24 hours after application. Ensure that frost or frozen surfaces are thawed and dry.
 - .2 Ensure that substrate surface and ambient air temperature are below of 32°C and remain below 32°C for at least 8 hours after application.

- .3 Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain temperature and conditions specified before proceeding with application.

Part 2 Products

2.1 MATERIALS

- .1 Rapid Setting Repair Mortar: Two-component, screedable, shrinkage-compensated, pre-extended, portland-cement-based, flowable repair mortar, with integral corrosion inhibitor with a minimum application thickness of 1 inch (25 mm).
 - .1 Properties:
 - .1 Unit Weight, ASTM C 185: 2,147 to 2,307 kg/m³.
 - .2 Working Time, 21°C: Greater than 30 minutes.
 - .3 Setting Time, ASTM C 266:
 - .1 Standard Application Temperature, 21°C:
 - .1 Initial Setting Time: 40 to 90 minutes.
 - .2 Final Setting Time: Less than 120 minutes.
 - .2 Maximum Application Temperature, 32°C:
 - .1 Initial Setting Time: 25 to 50 minutes.
 - .2 Final Setting Time: Less than 60 minutes.
 - .3 Minimum Application Temperature, 10°C:
 - .1 Initial Setting Time: 100 to 150 minutes.
 - .2 Final Setting Time: Less than 170 minutes.
 - .4 Compressive Strength, ASTM C 109, 23°C:
 - .1 3 Hours: Greater than 10.3 MPa (1,500 psi).
 - .2 1 Day: Greater than 20.7 MPa (3,000 psi).
 - .3 7 Days: Greater than 27.6 MPa (4,000 psi).
 - .4 28 Days: Greater than 34.5 MPa (5,000 psi).
 - .5 Drying Shrinkage, ASTM C 157, Modified, 28 Days: Less than 500 percent (μ strain).
 - .6 Rapid Chloride Permeability, ASTM C 1202/AASHTO T 277: Very low range, coulombs.
 - .7 Static Modulus of Elasticity, ASTM C 469, 28 Days: 22.1 GPa (3.2 x 10⁶ psi).
 - .8 Salt Scaling Resistance, ASTM C 672, 50 Cycles, Rating: 0.
 - .9 Coefficient of Thermal Expansion, CRD C 39: 1.46 x 10⁻⁵ m/m/degree C (8.1 x 10⁻⁶ in/in/degree F).
 - .10 Freezing and Thawing Resistance, ASTM C 666, Procedure A:
 - .1 Average Durability Factor, 300 Cycles: Greater than 80.
 - .11 Cracking Resistance, ASTM C 1581, plots of steel ring strain versus specimen age for each test specimen:
 - .1 Average Initial Strain: 0.09.

- .2 Average Maximum Strain: 41.47.
- .3 Average Age at Cracking: Greater than 60 days.
- .12 Compressive Creep, ASTM C 512, Average Creep Strain:
 - .1 7 Days: 0.008 μ strain/psi.
 - .2 28 Days: 0.034 μ strain/psi.
- .13 Direct Tensile Strength, CRD C 164, 2-inch by 4-inch specimens, Average Tensile Strength:
 - .1 1 Day: 350 psi.
 - .2 7 Days: 400 psi.
 - .3 28 Days: 500 psi.
- .14 Bond Strength, ASTM C 882, Modified per ASTM C 928, 3-inch by 6-inch slant-shear specimens, Average Slant-Shear Bond Strength:
 - .1 1 Day: Greater than 1,000 psi.
 - .2 7 Days: Greater than 1,500 psi.
 - .3 28 Days: Greater than 2,000 psi.
- .15 VOC Content: 0 lbs per gal (0 g/L), less water and exempt solvents.
- .2 Acceptable Product: ZERO-C Horizontal Extended Mortar by BASF Building Systems.
 - .1 Components:
 - .1 ZERO-C Horizontal Liquid.
 - .2 ZERO-C Extended Mortar.

2.2 ACCESSORIES

- .1 Evaporation retardant: Confilm by BASF Building Systems at a minimum application rate of 4.9 m²/L.

Part 3 Execution

3.1 PREPARATION

- .1 Protection: Protect adjacent Work areas and finish surfaces from damage during repair mortar application.
- .2 Surface Preparation:
 - .1 Complete concrete delamination repairs to 03 91 10 – Surface Preparation for Concrete Delamination Repairs.
- .3 The repair area must be thoroughly cleaned and well soaked prior to infilling. The surface should be thoroughly wetted for a period of not less than two (2) hours. The repair areas shall be kept continuously wet until just before infilling. Any standing water must be removed prior to grouting.
- .4 Maintain the substrate in a saturated, surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.

- .5 Obtain Contract Administrator's approval before placing concrete. Provide 24 hours notice prior to placing of concrete.
- .6 Forming:
 - .1 Unless otherwise indicated provide plywood formwork to match existing profiles.
 - .2 Install chamfers at outside corners and filets at inside corners in accordance with Section 03 10 00 or to match existing profiles.
 - .3 Design formwork to accommodate the mass and pressure of the repair material and construction live loads.
 - .4 Securely anchor formwork to substrate. Anchors to be sized and space to prevent deflection of the forms during placement and curing.
 - .5 Construct forms to fit tightly against existing concrete surfaces. Seal around edge of formwork with sealant to prevent leakage during grouting.
 - .6 Anchors shall be completely removable. All anchor holes shall be patched with same grout mixed to dry pack consistency. Completely fill all anchor holes.
 - .7 A minimum of 1 inch concrete cover over the primary reinforcing steel will be required, thus, an adjustment of the formwork such as a notch may be required to ensure sufficient cover.
 - .8 Use form-release agent to facilitate removal of forms from cast material.
 - .9 Test formwork for leaks. Any areas of leakage are to be sealed prior to placement of repair material. Re-test as required.

3.2 INFILLING PROCEDURES

- .1 Obtain Contract Administrator's approval before placing repair material. Provide minimum 24 hours notice.
- .2 Maintain the substrate in a saturated surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.
- .3 Mixing of rapid-setting mortar
 - .1 Mix materials in accordance with manufacturer's instructions.
 - .2 Precondition components to 16°C to 27° C for 24 hours before mixing.
 - .3 Ensure repair mortar is thoroughly mixed.
 - .4 Do not use free-fall mixers.
 - .5 Never mix partial bags.
- .4 Bonding Slurry Application:
 - .1 Apply the bonding slurry consisting of neat rapid-setting mortar to a saturated surface dry (SSD) substrate with no standing water and dry to the touch. A SSD substrate typically exhibits a colour change of dark grey to light grey. Remove standing water by vacuuming.
 - .2 Scrub plastic slurry into substrate with stiff bristled broom or brush to produce a uniform thickness of 1/8" over entire area.
 - .3 Place repair material while the bonding slurry is still plastic. Do not apply more slurry than can be covered with concrete before it dries. Do not retemper. If the bond slurry dries prior to placement of the concrete, removal of the dried slurry

will be required. The concrete substrate will then be cleaned and prepared in accordance with the requirements described in the previous sections.

- .5 Immediately place repair material, into the prepared patch area from one side to the other. Work the repair material firmly into the bottom and sides of the patch, and underneath reinforcing steel, to assure good bond.
- .6 Ensure that rate of placing is sufficient to complete proposed placing, finishing and curing operations within scheduled time. Limit batch sizes as required if placing procedures are slower than anticipated.
- .7 Continuously consolidate and finish to matching elevations, ensuring patch thickness and required elevations are maintained.
- .8 Ensure reinforcement, floor drains, inserts, etc. are not disturbed during concrete placement.

3.3 FINISHING

- .1 Following consolidation and screeding, the surface shall be immediately bull-floated to close and smooth the surface.
- .2 Surface to receive a smooth finish free of ridges and trowel marks.
- .3 Apply evaporation retardant at manufacturers recommended coverage rate immediately following final finishing. Do not apply evaporation retardant during any finishing operation nor should it be worked into the surface.
- .4 Protect freshly placed concrete from exposure to dust, debris and precipitation.

3.4 CURING

- .1 Concrete repairs to be wet cured for a minimum of 3 days at 10°C.
- .2 Immediately after final finishing, apply evaporation retardant to prevent drying shrinkage until the concrete has enough strength to support the placement of the wet burlap.
- .3 Burlap to be thoroughly presoaked by immersing it in water for a period of at least 24 hours immediately prior to placement.
- .4 Commence wet curing as soon as the surface will support the weight of the wetted burlap without deformation. Burlap to be applied in one layer with strips overlapping at least 3" and be securely held in place without marring the concrete surface.
- .5 Wet curing with burlap and water must be maintained throughout entire curing period.
- .6 Workers shall not be allowed on the overlay for 12 hours after placement. Do not place load upon new concrete until curing period is over.
- .7 Leave formwork in place until repair mortar reaches compressive strength for minimum 3 days.

3.5 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Contract Administrator in accordance with CSA-A23.1 and Section 01 45 00 - Quality Control and as described herein.
- .2 The Contractor will pay for costs of tests via the testing cash allowance as per Section 01 2 10 - Allowances.
- .3 Not less than one test per 50 square feet of patching material placed and not less than one test for each day of placement.
 - .1 Test samples to be prepared by a CSA certified laboratory in accordance with ASTM C109.
- .4 Bond tests will be completed at the discretion of the Contract Administrator.
 - .1 Infilling of the core hole will be the responsibility of the General Contractor. Unless otherwise directed by the Contract Administrator, repair in accordance with this Section.
- .5 Testing agency to submit copies of concrete test reports directly to Contract Administrator.
- .6 Inspection or testing by Contract Administrator will not augment or replace Contractor quality control nor relieve contractual responsibility.

3.6 DEFECTIVE CONCRETE

- .1 Defective concrete: bond strengths below minimum specified value, cracking, spalling, scaling and concrete not conforming to required lines, details, dimensions, tolerances, finishes or specified requirements.
- .2 Repair or replacement of defective concrete will be determined by the Contract Administrator, based on the specifications and the above guidelines.
- .3 Do not patch, fill, touch up, repair or replace exposed concrete except upon express direction of Contract Administrator for each individual use.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Slab soffit areas, beams, columns, and walls exhibiting extensive spalling and/or delamination requiring localized repairs less than 2 inches in depth will be repaired by removing the deteriorated concrete, cleaning and preparing the substrate, and patching the area with a cementitious patching material

1.2 RELATED SECTIONS

- .1 Section 03 20 00 – Concrete Reinforcing.
- .2 Section 03 91 10 – Surface Preparation for Concrete Delamination Repairs.

1.3 REFERENCES

- .1 ACI 546-04, Concrete Repair Guide.
- .2 ACI RAP-6, Vertical and Overhead Spall Repair by Hand Application.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM C109/C109M-08, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. (50-mm) Cube Specimens).
 - .2 ASTM C309-03, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .3 ASTM C1315-08, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- .3 Canadian Standards Association (CSA)
 - .1 CSA- S448.1-10, Repair of Reinforced Concrete in Buildings.
- .4 International Concrete Repair Institute (ICRI)
 - .1 ICRI concrete Repair Terminology (2010 Edition).
 - .2 ICRI Guideline No. 120.1–2009, Guidelines and Recommendations for Safety in the Concrete Repair Industry.
 - .3 ICRI Guideline No. 130.1R–2009, Guide for Methods of Measurement and Contract Types for Concrete Repair Work (formerly No. 03735).

1.4 MEASUREMENT PROCEDURES

- .1 The areas of repair will be identified and quantified via hammer soundings by the Contract Administrator in the presence of and with the assistance of the Contractor. The areas will then be measured and agreed upon by the Contractor and Contract Administrator prior to commencement of work.
- .2 Unit prices must include all supervision, labour and materials, and equipment.

- .3 The unit price submitted will apply to removal depths of up to 2 inches and at no point less than 1/2 inch in depth. Repairs over 2 inches in depth will be repaired via pressure grouting in accordance with Section 03 93 20.
- .4 The minimum area of payment will be one 1/2 square foot.
- .5 The Contractor is to note that if the area of the repair is increased over that originally measured without consultation with the Contract Administrator, then the Contractor will not be paid for the increased area.

1.5 QUALITY ASSURANCE

- .1 Contractor Qualifications:
 - .1 Minimum of 5 years experience in application of specified (or similar) products on projects of similar size and scope.
 - .2 Successful completion of a minimum of 5 projects of similar size and complexity to specified Work within the last 3 years.
- .2 Field Mock-up:
 - .1 Upon request, install field mock-up at Project site or pre-selected area of building or location approved by Contract Administrator. Install material in accordance with this Section.
 - .2 Field mock-up will be standard for judging workmanship on remainder of Project.
 - .3 Manufacturer's representative or designated representative will review technical aspects; surface preparation, repair, and workmanship.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Comply with Section 01 61 00.
- .2 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .3 Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures.
- .4 Keep materials in manufacturer's original, unopened containers and packaging until installation.
- .5 Protect materials during storage, handling, and application to prevent contamination or damage.

1.7 PROJECT CONDITIONS

- .1 Environmental Requirements:
 - .1 Ensure that substrate surface and ambient air temperature are minimum of 4°C and rising at application time and remain above 4°C for at least 24 hours after application. Ensure that frost or frozen surfaces are thawed and dry.

- .2 Ensure that substrate surface and ambient air temperature are below of 32°C and remain below 32°C for at least 8 hours after application.
- .3 Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain temperature and conditions specified before proceeding with application.

Part 2 Products

2.1 MATERIALS

- .1 Patching Mortar: Infilling with a one-component, thixotropic, rheoplastic, cement-based, fiber-reinforced, shrinkage-compensated, sulfate-resistant structural repair mortar.
 - .1 Drying shrinkage to ASTM C157:
 - .1 less than 0.10% at 28 days.
 - .2 Compressive Strength to ASTM C109:
 - .1 Minimum 7 MPa at 3 hours.
 - .2 Minimum 21 MPa at 1 day.
 - .3 Minimum 28 MPa at 7 days.
 - .3 Modulus of elasticity to ASTM C469:
 - .1 25×10^3 MPa \pm 10×10^3 MPa.
 - .4 Freeze/Thaw Resistance to ASTM C 666, Procedure A:
 - .1 Minimum 96.0% RDM at 300 cycles.
 - .5 Salt Scale Resistance to ASTM C672:
 - .1 Less than 0.05 kg/m² at 50 cycles.
- .2 Acceptable product(s):
 - .1 Emaco S88 CI by BASF Building Systems.
 - .2 Planitop X by Mapei.

2.2 ACCESSORIES

- .1 Evaporation retardant: Confilm by BASF Building Systems at a minimum application rate of 4.9 m²/L.
- .2 Cure and sealing compound: to ASTM C309, Type 1. Acceptable product(s):
 - .1 Florseal WB by Sika Canada Inc. at a minimum application rate of 4.9 m²/L.
 - .2 Kure-N-Seal WB by BASF Building Systems at a minimum application rate of 4.9 m²/L.

Part 3 Execution

3.1 PREPARATION

- .1 Protection: Protect adjacent Work areas and finish surfaces from damage during repair mortar application.

- .2 Surface Preparation:
 - .1 Complete concrete delamination repairs to 03 91 10 – Surface Preparation for Concrete Delamination Repairs.
- .3 The repair area must be thoroughly cleaned and well soaked prior to infilling. The surface should be thoroughly wetted for a period of not less than two (2) hours. The repair areas shall be kept continuously wet until just before infilling. Any standing water must be removed prior to grouting.
- .4 Maintain the substrate in a saturated, surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.

3.2 APPLICATION PROCEDURES

- .1 Obtain Contract Administrator's approval before placing repair material. Provide minimum 24 hours notice.
- .2 The patch material must be installed and cured in strict accordance with manufacturer's specifications.
- .3 Apply repair mortar to a saturated surface dry (SSD) substrate with no standing water and dry to the touch. A SSD substrate typically exhibits a colour change of dark grey to light grey.
- .4 Apply a bond slurry, consisting of neat patching mortar, to the prepared surface. Thoroughly scrub a thin layer of normal consistency mortar into the saturated surface with a stiff bristle brush to produce a uniform thickness of approximately 1/8" over entire area.
- .5 Apply repair mortar by hand troweling on vertical or overhead surfaces in depths ranging from 1/2" to 2".
 - .1 Vertical Applications: Repair mortar can be applied on vertical applications up to a 2" depth per lift.
 - .2 Overhead Applications: Do not exceed 1.5" thickness per lift. For depths greater than 1.5", limit succeeding lifts to 1" thickness.
 - .3 Multiple Passes: Place succeeding lifts after repair mortar has developed initial set. Scarify the surface of the first lift to ensure integral bond between successive layers.

3.3 FINISHING

- .1 Level surface of repair mortar using a float or screed.
- .2 Apply final finish when mortar has begun to stiffen using a wooden, plastic, or synthetic sponge float or trowel.
- .3 Spray apply undiluted evaporation reducer lightly to aid in finishing.
- .4 Trim or shape to the desired profile if required.

3.4 CURING

- .1 Apply two coats of curing compound in accordance with manufacturer's specifications. Apply the first coat immediately after completing finishing operations. Apply the second coat about 24 hours later.

3.5 CURING

- .1 Protect fresh mortar from premature evaporation.
- .2 Concrete repairs to be wet cured for a minimum of 3 days at 10°C.
- .3 Apply two coats curing compound in accordance with manufacturer's specifications. Apply the first coat immediately upon removal of forms. Apply the second coat about 24 hours later.

3.6 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Contract Administrator in accordance with CSA-A23.1 and Section 01 45 00 - Quality Control and as described herein.
- .2 The Contractor will pay for costs of tests via the testing cash allowance as per Section 01 2 10 - Allowances.
- .3 Not less than one test per 50 square feet of patching material placed and not less than one test for each day of placement.
 - .1 Test samples to be prepared by a CSA certified laboratory in accordance with ASTM C109.
- .4 Bond tests will be completed at the discretion of the Contract Administrator.
 - .1 Infilling of the core hole will be the responsibility of the General Contractor. Unless otherwise directed by the Contract Administrator, repair in accordance with this Section.
- .5 Testing agency to submit copies of concrete test reports directly to Contract Administrator.
- .6 Inspection or testing by Contract Administrator will not augment or replace Contractor quality control nor relieve contractual responsibility.

3.7 DEFECTIVE CONCRETE

- .1 Defective concrete: bond strengths below minimum specified value, cracking, spalling, scaling and concrete not conforming to required lines, details, dimensions, tolerances, finishes or specified requirements.
- .2 Repair or replacement of defective concrete will be determined by the Contract Administrator, based on the specifications and the above guidelines.
- .3 Do not patch, fill, touch up, repair or replace exposed concrete except upon express direction of Contract Administrator for each individual use.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Slab soffit areas, beams, columns and walls exhibiting extensive spalling and/or delamination in which patching would be uneconomical are to be repaired by mechanical removal of the deteriorated concrete and replacement with a pumpable grout.
- .2 All spalling and/or delaminated concrete must be removed down to sound concrete in accordance with Section 03 91 10.

1.2 RELATED SECTIONS

- .1 Section 03 20 00 – Concrete Reinforcing.
- .2 Section 03 91 10 – Surface Preparation for Concrete Delamination Repairs.
- .3 Section 03 93 10 – Hand Patching.
- .4 Section 07 92 10 – Concrete Joint Sealants.

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 ACI 546-04, Concrete Repair Guide.
 - .2 ACI RAP-5, Surface Repair Using Form-and-Pump Techniques.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM C109/C109M-08, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. (50-mm) Cube Specimens).
 - .2 ASTM C309-07, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- .3 Canadian Standards Association (CSA)
 - .1 CSA- S448.1-10, Repair of Reinforced Concrete in Buildings.
- .4 International Concrete Repair Institute (ICRI)
 - .1 ICRI concrete Repair Terminology (2010 Edition).
 - .2 ICRI Guideline No. 120.1–2009, Guidelines and Recommendations for Safety in the Concrete Repair Industry.
 - .3 ICRI Guideline No. 130.1R–2009, Guide for Methods of Measurement and Contract Types for Concrete Repair Work (formerly No. 03735).

1.4 MEASUREMENT PROCEDURES

- .1 The areas of repair will be identified and quantified via hammer soundings by the Contract Administrator in the presence of and with the assistance of the Contractor. The areas will

then be measured and agreed upon by the Contractor and Contract Administrator prior to commencement of work.

- .2 Unit prices must include all supervision, labour and materials, and equipment.
- .3 The unit price submitted will apply to removal depths of up to a 3 inches and at no point less than 2 inches in depth. A second unit price must also be submitted which will apply to removal depths of up to a 6 inch depth and at no point less than 3 inches in depth.
- .4 The minimum area of payment will be one (1) square foot.
- .5 The Contractor is to note that if the area of the repair is increased over that originally measured without consultation with the Contract Administrator, then the Contractor will not be paid for the increased area.

1.5 QUALITY ASSURANCE

- .1 Contractor Qualifications:
 - .1 Minimum of 5 years experience in application of specified (or similar) products on projects of similar size and scope.
 - .2 Successful completion of a minimum of 5 projects of similar size and complexity to specified Work within the last 3 years.
- .2 Field Mock-up:
 - .1 Upon request, install field mock-up at Project site or pre-selected area of building or location approved by Contract Administrator. Install material in accordance with this Section.
 - .2 Field mock-up will be standard for judging workmanship on remainder of Project.
 - .3 Manufacturer's representative or designated representative will review technical aspects; surface preparation, repair, and workmanship.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Comply with Section 01 61 00.
- .2 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .3 Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures.
- .4 Keep materials in manufacturer's original, unopened containers and packaging until installation.
- .5 Protect materials during storage, handling, and application to prevent contamination or damage.

1.7 PROJECT CONDITIONS

- .1 Environmental Requirements:

- .1 Ensure that substrate surface and ambient air temperature are minimum of 4°C and rising at application time and remain above 4°C for at least 24 hours after application. Ensure that frost or frozen surfaces are thawed and dry.
- .2 Ensure that substrate surface and ambient air temperature are below of 32°C and remain below 32°C for at least 8 hours after application.
- .3 Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain temperature and conditions specified before proceeding with application.

Part 2 Products

2.1 MATERIALS

- .1 One-component, shrinkage-compensated, micro concrete consisting of cement, graded aggregate, shrinkage-compensating agents, and additives complying with the following performance requirements:
 - .1 Compressive Strength, ASTM C109:
 - .1 1 day: minimum 17.0 MPa.
 - .2 7 days: minimum 34.5 MPa.
 - .3 28 days: minimum 41.0 MPa.
 - .2 Slant Sheer Bond Strength, ASTM C 882:
 - .1 1 Day: minimum 5.0 MPa.
 - .2 7 Days: minimum 10.0 MPa.
 - .3 28 days: minimum 16.0 MPa.
 - .3 Drying Shrinkage, ASTM C157, Unmodified, 1-inch (25-mm) prisms:
 - .1 28 Days: less than 350 µstrain.
 - .4 Drying Shrinkage, ASTM C157, Modified, 3-inch (76-mm) prisms, air cured at 73 degrees F (23 degrees C), 50 percent relative humidity:
 - .1 7 Days: less than 225 µstrain.
 - .2 28 Days: less than 500 µstrain.
 - .5 Coefficient of Thermal Expansion, ASTM C531:
 - .1 28 days: $10 \pm 0.1 \times 10^{-6}$ cm/cm per degree C.
 - .6 Freeze/Thaw Resistance, ASTM C666 at 300 cycles:
 - .1 minimum 96% relative dynamic modulus.
 - .7 Splitting Tensile Strength, ASTM C496:
 - .1 28 days: minimum 4.0 MPa.
 - .8 Rapid Chloride Permeability, ASTM C1202:
 - .1 Less than 1,000 Coulombs
- .2 Acceptable product is:
 - .1 LA Repair Mortar by BASF Building Systems.

2.2 EQUIPMENT

- .1 Pumping equipment: Mono-type, piston/ball valve, or hydraulic/swing valve pumps capable of pumping specified grout. Pumping equipment must have adequate controls to regulate flow rates and pressures

2.3 ACCESSORIES

- .1 Cure and sealing compound: to ASTM C309, Type 1. Acceptable product(s):
 - .1 Florseal WB by Sika Canada Inc. at a minimum application rate of 4.9 m²/L.
 - .2 Kure-N-Seal WB by BASF Building Systems at a minimum application rate of 4.9 m²/L.
- .2 Sealants: to Section 07 91 20.

Part 3 Execution

3.1 PREPARATION

- .1 Protection: Protect adjacent Work areas and finish surfaces from damage during repair mortar application.
- .2 Surface Preparation:
 - .1 Complete concrete delamination repairs to 03 91 10 – Surface Preparation for Concrete Delamination Repairs.
- .3 The repair area must be thoroughly cleaned and well soaked prior to infilling. The surface should be thoroughly wetted for a period of not less than two (2) hours. The repair areas shall be kept continuously wet until just before infilling. Any standing water must be removed prior to grouting.
- .4 Maintain the substrate in a saturated, surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.
- .5 Forming:
 - .1 Unless otherwise indicated provide plywood formwork to match existing profiles.
 - .2 Install chamfers at outside corners and filets at inside corners in accordance with Section 03 10 00 or to match existing profiles.
 - .3 Design formwork to accommodate the mass and pressure of the repair material but not less than 14 psi (100 kPa).
 - .4 Securely anchor formwork to substrate. Anchors to be sized and space to prevent deflection of the forms during pressure grouting.
 - .5 Construct forms to fit tightly against existing concrete surfaces. Seal around edge of formwork with sealant to prevent leakage during grouting.
 - .6 Anchors shall be completely removable. All anchor holes shall be patched with same grout utilized for the repairs but mixed to dry pack consistency. Completely fill all anchor holes.

- .7 A minimum of 1 inch concrete cover over the primary reinforcing steel will be required, thus, an adjustment of the formwork such as a notch may be required to ensure sufficient cover.
- .8 Provide drainage outlets in formwork for presoaking and, if beneath a soffit, provide air venting. Provide suitable access points to pump mixed repair mortar into place.
- .9 Space ports for pump line attached in a grid pattern.
- .10 Use form-release agent to facilitate removal of forms from cast material.
- .11 Within two (2) hours immediately prior to grouting, pressure test formwork to determine watertightness. Completely fill formwork with clean water and let stand for not less than 15 minutes. Any areas of leakage are to be sealed prior to grouting. Re-test as required.

3.2 INFILLING PROCEDURES

- .1 Obtain Contract Administrator's approval before placing repair material. Provide minimum 24 hours notice.
- .2 Maintain the substrate in a saturated, surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.
- .3 Mixing:
 - .1 Mix materials in accordance with manufacturer's instructions.
 - .2 Ensure repair mortar is thoroughly mixed.
 - .3 Do not use free-fall mixers.
 - .4 Never mix partial bags.
- .4 Within 15 minutes of mixing, pump the grout into the prepared form. Work in a manner to avoid air entrapment with a variable pressure pump.
- .5 Start pumping at one corner for horizontal surfaces, or at the lowest point for vertical surfaces, continue filling in a manner that prevents air entrapment.
- .6 Continue pumping until material flows from adjacent ports and all air is expelled. After all air is expelled, temporarily stop pumping, close off port, and begin pumping from next port that has seen material flow. Repeat sequence until the cavity is completely filled.
- .7 Monitor pump-line pressure to prevent excessive back-pressure when pumping long distances.
- .8 Vibrate the form while pumping, as required, to achieve flow and compaction. Flowable grout must be confined in either the horizontal or vertical direction, leaving a minimum of exposed surface.

3.3 CURING

- .1 Concrete repairs to be cured for a minimum of 3 days at 10°C.
- .2 Leave formwork in place until repair mortar reaches compressive strength of 20 MPa but not less than 3 days.

- .3 Upon removal of forms, apply two coats curing compound in accordance with manufacturer's specifications. Apply the first coat immediately upon removal of forms. Apply the second coat about 24 hours later.

3.4 FINISHING

- .1 After stripping of formwork, any spaces not filled should be trimmed, cleaned, and dry-packed with grout to the desired profile. Do not proceed with repairs without Contract Administrators written approval.

3.5 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Contract Administrator in accordance with CSA-A23.1 and Section 01 45 00 - Quality Control and as described herein.
- .2 The Contractor will pay for costs of tests via the testing cash allowance as per Section 01 2 10 - Allowances.
- .3 Not less than one test per [50 square feet] of patching material placed and not less than one test for each day of placement.
 - .1 Test samples to be prepared by a CSA certified laboratory in accordance with ASTM C109.
- .4 Bond tests will be completed at the discretion of the Contract Administrator.
 - .1 Infilling of the core hole will be the responsibility of the General Contractor. Unless otherwise directed by the Contract Administrator, repair in accordance with this Section.
- .5 Testing agency to submit copies of concrete test reports directly to Contract Administrator.
- .6 Inspection or testing by Contract Administrator will not augment or replace Contractor quality control nor relieve contractual responsibility.

3.6 DEFECTIVE CONCRETE

- .1 Defective concrete: bond strengths below minimum specified value, cracking, spalling, scaling and concrete not conforming to required lines, details, dimensions, tolerances, finishes or specified requirements.
- .2 Repair or replacement of defective concrete will be determined by the Contract Administrator, based on the specifications and the above guidelines.
- .3 Do not patch, fill, touch up, repair or replace exposed concrete except upon express direction of Contract Administrator for each individual use.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Slab soffit areas, beams, columns and walls exhibiting extensive spalling and/or delamination in which patching would be uneconomical are to be repaired by mechanical removal of the deteriorated concrete and replacement using the form and pour method.
- .2 All spalling and/or delaminated concrete must be removed down to sound concrete in accordance with Section 03 91 10.

1.2 RELATED SECTIONS

- .1 Section 03 20 00 – Concrete Reinforcing.
- .2 Section 03 91 10 – Surface Preparation for Concrete Delamination Repairs.
- .3 Section 07 92 10 – Concrete Joint Sealants.

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 ACI 546-04, Concrete Repair Guide.
 - .2 ACI RAP-4, Surface Repair Using Form-and-Pour Techniques.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM C109/C109M-08, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. (50-mm) Cube Specimens).
 - .2 ASTM C309-03, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- .3 Canadian Standards Association (CSA)
 - .1 CSA- S448.1-10, Repair of Reinforced Concrete in Buildings.
- .4 International Concrete Repair Institute (ICRI)
 - .1 ICRI concrete Repair Terminology (2010 Edition).
 - .2 ICRI Guideline No. 120.1–2009, Guidelines and Recommendations for Safety in the Concrete Repair Industry.
 - .3 ICRI Guideline No. 130.1R–2009, Guide for Methods of Measurement and Contract Types for Concrete Repair Work (formerly No. 03735).
 - .4 ICRI Guideline No. 320.3-2007, Guideline for Inorganic Repair Material Data Sheet Protocol (formerly No. 03740).

1.4 MEASUREMENT PROCEDURES

- .1 The areas of repair will be identified and quantified via hammer soundings by the Contract Administrator in the presence of and with the assistance of the Contractor. The areas will

then be measured and agreed upon by the Contractor and Contract Administrator prior to commencement of work.

- .2 Unit prices must include all supervision, labour and materials, and equipment.
- .3 The unit price submitted will apply to removal depths of up to a 3 inches and at no point less than 2 inches in depth. A second unit price must also be submitted which will apply to removal depths of up to a 6 inch depth and at no point less than 3 inches in depth.
- .4 The minimum area of payment will be one (1) square foot.
- .5 The Contractor is to note that if the area of the repair is increased over that originally measured without consultation with the Contract Administrator, then the Contractor will not be paid for the increased area.

1.5 QUALITY ASSURANCE

- .1 Contractor Qualifications:
 - .1 Minimum of 5 years experience in application of specified (or similar) products on projects of similar size and scope.
 - .2 Successful completion of a minimum of 5 projects of similar size and complexity to specified Work within the last 3 years.
- .2 Field Mock-up:
 - .1 Upon request, install field mock-up at Project site or pre-selected area of building or location approved by Contract Administrator. Install material in accordance with this Section.
 - .2 Field mock-up will be standard for judging workmanship on remainder of Project.
 - .3 Manufacturer's representative or designated representative will review technical aspects; surface preparation, repair, and workmanship.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Comply with Section 01 61 00.
- .2 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .3 Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures.
- .4 Keep materials in manufacturer's original, unopened containers and packaging until installation.
- .5 Protect materials during storage, handling, and application to prevent contamination or damage.

1.7 PROJECT CONDITIONS

- .1 Environmental Requirements:

- .1 Ensure that substrate surface and ambient air temperature are minimum of 4°C and rising at application time and remain above 4°C for at least 24 hours after application. Ensure that frost or frozen surfaces are thawed and dry.
- .2 Ensure that substrate surface and ambient air temperature are below of 32°C and remain below 32°C for at least 8 hours after application.
- .3 Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain temperature and conditions specified before proceeding with application.

Part 2 Products

2.1 MATERIALS

- .1 The repair mortar shall cement-based, one-component, self-consolidating with the following properties:
 - .1 Drying shrinkage to ASTM C157:
 - .1 less than 0.10% at 28 days.
 - .2 Compressive Strength, ASTM C109:
 - .1 1 day: minimum 10.0 MPa.
 - .2 7 days: minimum 28.0 MPa.
 - .3 28 days: minimum 35.0 MPa.
 - .3 Freeze/Thaw Resistance, ASTM C666 at 300 cycles:
 - .1 minimum 98% relative dynamic modulus.
 - .4 Coefficient of Thermal Expansion, ASTM C531:
 - .1 28 days: $10 \pm 1.0 \times 10^{-6}$ cm/cm per degree C.
- .2 Acceptable product is:
 - .1 LA40 Repair Mortar by BASF Building Systems.
 - .2 Sikacrete-08 SCC by Sika Canada.

2.2 ACCESSORIES

- .1 Cure and sealing compound: to ASTM C309, Type 1. Acceptable product(s):
 - .1 Florseal WB by Sika Canada Inc. at a minimum application rate of 4.9 m²/L.
 - .2 Kure-N-Seal WB by BASF Building Systems at a minimum application rate of 4.9 m²/L.
- .2 Sealants: to Section 07 91 20.

Part 3 Execution

3.1 PREPARATION

- .1 Protection: Protect adjacent Work areas and finish surfaces from damage during repair mortar application.

- .2 Surface Preparation:
 - .1 Complete concrete delamination repairs to 03 91 10 – Surface Preparation for Concrete Delamination Repairs.
- .3 The repair area must be thoroughly cleaned and well soaked prior to infilling. The surface should be thoroughly wetted for a period of not less than two (2) hours. The repair areas shall be kept continuously wet until just before infilling. Any standing water must be removed prior to grouting.
- .4 Maintain the substrate in a saturated, surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.
- .5 Forming:
 - .1 Unless otherwise indicated provide plywood formwork to match existing profiles.
 - .2 Install chamfers at outside corners and filets at inside corners in accordance with Section 03 10 00 or to match existing profiles.
 - .3 Design formwork to accommodate the mass and pressure of the repair material.
 - .4 Securely anchor formwork to substrate. Anchors to be sized and space to prevent deflection of the forms placement and curing.
 - .5 Construct forms to fit tightly against existing concrete surfaces. Seal around edge of formwork with sealant to prevent leakage during grouting.
 - .6 Anchors shall be completely removable. All anchor holes shall be patched with grout mixed to dry pack consistency. Completely fill all anchor holes.
 - .7 Placement openings or chutes are required to place the repair material behind vertical forms. Chutes should be constructed to permit development of a hydraulic head above the prepared upper edges of the concrete surface. This will provide for repair material supply into these upper horizontal zones after concrete is consolidated.
 - .8 For large, vertical surfaces exceeding 10 ft (3 m) in height, multiple lifts should be considered to reduce free-fall segregation and excessive formwork pressures.
 - .9 Formwork for overhead surfaces does not require openings for placement of repair materials. Place repair materials through openings in the slab from above. Size and location of openings to be approved by Contract Administrator. Do not remove or cause damage to existing reinforcing steel in order to install placement openings.
 - .10 A minimum of 1 inch concrete cover over the primary reinforcing steel will be required, thus, an adjustment of the formwork such as a notch may be required to ensure sufficient cover.
 - .11 Provide drainage outlets in formwork for presoaking and, if beneath a soffit, provide air venting. Provide suitable access points to pour mixed repair mortar into place.
 - .12 Use form-release agent to facilitate removal of forms from cast material.
 - .13 Within two (2) hours immediately prior to placement of repair material, test formwork to determine watertightness. Completely fill formwork with clean water and let stand for not less than 15 minutes. Any areas of leakage are to be sealed prior to placement of repair material. Re-test as required.

3.2 INFILLING PROCEDURES

- .1 Obtain Contract Administrator's approval before placing repair material. Provide minimum 24 hours notice.
- .2 Maintain the substrate in a saturated, surface-dry (SSD) condition with no surface water, and concrete that is turning from dark to light.
- .3 Mixing:
 - .1 Mix materials in accordance with manufacturer's instructions.
 - .2 Precondition components to 16°C to 27° C for 24 hours before mixing.
 - .3 Ensure repair mortar is thoroughly mixed.
 - .4 Do not use free-fall mixers.
 - .5 Never mix partial bags.
- .4 Within 15 minutes of mixing, pour repair material into the prepared form. Work in a manner to avoid air entrapment with a variable pressure pump.
- .5 Ensure that the uppermost surfaces are filled adjacent to the chute or opening where placement occurs. Rod or tamp material to ensure proper filling.

3.3 CURING

- .1 Concrete repairs to be cured for a minimum of 3 days at 10°C.
- .2 Leave formwork in place until repair mortar reaches compressive strength of 20 MPa but not less than 3 days.
- .3 Upon removal of forms, apply two coats curing compound in accordance with manufacturer's specifications. Apply the first coat immediately upon removal of forms. Apply the second coat about 24 hours later.

3.4 FINISHING

- .1 After stripping of formwork, any spaces not filled should be trimmed, cleaned, and dry-packed with grout to the desired profile. Do not proceed with repairs without Contract Administrators written approval.

3.5 FIELD QUALITY CONTROL

- .1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Contract Administrator in accordance with CSA-A23.1 and Section 01 45 00 - Quality Control and as described herein.
- .2 The Contractor will pay for costs of tests via the testing cash allowance as per Section 01 2 10 - Allowances.
- .3 Not less than one test per [50 square feet] of patching material placed and not less than one test for each day of placement.

- .1 Test samples to be prepared by a CSA certified laboratory in accordance with ASTM C109.
- .4 Bond tests will be completed at the discretion of the Contract Administrator.
 - .1 Infilling of the core hole will be the responsibility of the General Contractor. Unless otherwise directed by the Contract Administrator, repair in accordance with this Section.
- .5 Testing agency to submit copies of concrete test reports directly to Contract Administrator.
- .6 Inspection or testing by Contract Administrator will not augment or replace Contractor quality control nor relieve contractual responsibility.

3.6 DEFECTIVE CONCRETE

- .1 Defective concrete: bond strengths below minimum specified value, cracking, spalling, scaling and concrete not conforming to required lines, details, dimensions, tolerances, finishes or specified requirements.
- .2 Repair or replacement of defective concrete will be determined by the Contract Administrator, based on the specifications and the above guidelines.
- .3 Do not patch, fill, touch up, repair or replace exposed concrete except upon express direction of Contract Administrator for each individual use.

END OF SECTION