(Replaces OPSS.PROV 930, November 2014, with minor formatting changes only.)

CONSTRUCTION SPECIFICATION FOR STRUCTURE REHABILITATION - CONCRETE PATCHES, REFACING, AND OVERLAYS

TABLE OF CONTENTS

930.01 SCOPE

This specification covers the requirements for concrete structure rehabilitation, including; concrete patches, concrete refacing, normal concrete overlays, and silica fume concrete overlays.

930.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Construction

OPSS 904 Concrete Structures
OPSS 905 Steel Reinforcement for Concrete
OPSS 919 Formwork and Falsework
OPSS 928 Structure Rehabilitation - Concrete Removal
OPSS 929 Abrasive Blast Cleaning - Concrete Construction
OPSS 932 Crack Repair - Concrete

Ontario Provincial Standard Specification, Material

OPSS 1302 Water
OPSS 1350 Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Structure Rehabilitation Manual

MTO Laboratory Testing Manual:
LS-430 Method of Test for Bond Strength by Tensile Load
LS-435 Method of Test for Linear Shrinkage of Concrete
LS-601 Materials Finer than 75 µm Sieve in Mineral Aggregates by Washing
LS-607 Determination of Percent Crushed Particles in Processed Coarse Aggregate

MTO Forms:
PH-CC-736 Notification of Placement of Concrete

CSA Standards

A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing*
C22.2 No. 211.2-M1984 (1992) Rigid PVC (Un-plasticized) Conduit
G30.5-M1983 (R1998) Welded Steel Wire Fabric for Concrete Reinforcement

* [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153-09 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
D4285-83-(R2006) Method for Indicating Oil or Water in Compressed Air

930.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Concrete Patches, Formed Surfaces means concrete patches where at least one face of the patch requires formwork.

Concrete Patches, Unformed Surfaces means concrete patches located in the top surface of decks, sidewalks, and curbs where no formwork is required.

Concrete Refacing means concrete refacing where at least one of the surfaces of a component is entirely overlaid with concrete. Concrete refacing typically applies to pier columns, pier caps, abutments, vertical walls of culverts and tunnels, concrete barrier, and parapet walls.

Form and Pump Placement Method means a method of placing concrete by pumping directly into formwork through injection ports.

Hot Weather means those conditions when the air temperature is at or above 28°C. It is also considered to exist when the air temperature is at or is likely to rise above 28°C within 24 hours after concrete placement. Temperature refers to shade temperature.

Injection Port means a mechanical device with a manual shut-off that is attached to the formwork and connected to the discharge line of a pump to facilitate delivery of concrete directly into the formwork.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Self-Consolidating Concrete (SCC) means a highly flowable yet stable concrete that can spread readily into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation or vibration and without undergoing segregation or excessive bleeding. It may be designed for high strength and durability in addition to flow characteristics.

Segregation means visible separation of the mortar and coarse aggregate particles in the plastic concrete resulting in concrete that is not uniform in appearance or proportions.

Silica Fume Concrete means concrete which includes silica fume and may in addition include other supplementary cementing materials having specified rapid chloride permeability at 28 to 32 Days of 1,000 coulombs or less.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway, or any part thereof or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

930.04 DESIGN AND SUBMISSION REQUIREMENTS

930.04.01 Design Requirements

930.04.01.01 Formwork and Falsework

Design submission shall be according to OPSS 919 with the following additional requirements:

a) Working Drawings for soffit repairs shall be designed and sealed by an Engineer.

b) Formwork and falsework for soffit repairs subjected to live traffic vibrations on the deck shall be designed for an additional dynamic load allowance of 50% the weight of plastic concrete being supported.

Timber formwork and falsework for soffit repairs shall be designed using permanent load duration factors and shall accommodate additional pressure due to pumping of repair concrete.

930.04.02 Submission Requirements

930.04.02.01 Notification of Placement of Concrete

Prior to each placing operation, form PH-CC-736, accompanied by all supporting documentation as indicated on the form shall be submitted to the Contract Administrator.

930.04.02.02 Cold Weather Protection

930.04.02.02.01 General

A description of the methods to be used to control the concrete temperature and temperature difference in cold weather shall be submitted to the Contract Administrator 3 Days prior to the commencement of concrete

production. Cold weather is considered to exist when the air temperature is at or below 10°C. It is also considered to exist when the air temperature is at or is likely to fall below 10°C within 96 hours after concrete placement. Temperature refers to shade temperature. The submission shall be according to the Temperature Control Plans clause of OPSS 904.

930.04.02.02.02 Temperature Records

Datalogger temperature records and a record of any actions taken to maintain control of temperature and temperature difference shall be submitted to the Contract Administrator at the end of each Business Day during the temperature monitoring period. At the end of the temperature monitoring period, a complete temperature record shall be submitted to the Contract Administrator.

930.04.02.03 Concrete Mix Design

Concrete mix design submissions shall be according to OPSS 1350, with the additional requirement that test data for linear shrinkage shall be required and submitted within 40 Days of the mix design submission.

930.04.02.04 Hot Weather Concreting

A description of the methods to be used to control the concrete temperature shall be submitted to the Contract Administrator 3 Days prior to the commencement of concrete production in hot weather.

930.04.02.05 Placement Methods

When the form and pump placement method is specified in the Contract Documents or self-consolidating concrete is used, 4 copies of the details of the placement method shall be submitted to the Contract Administrator at least 3 Days prior to commencement of the work. The details shall include methodology and equipment to be used and shall bear the seal and signature of an Engineer.

930.04.02.06 Formwork and Falsework

Working Drawings for soffit repairs shall be submitted to the Contract Administrator 3 Days prior to the commencement of formwork and falsework installation, for information purposes only.

930.05 MATERIALS

930.05.01 General

The following materials shall be according to OPSS 904:

a) Burlap.

b) Insulation material.

c) Moisture vapour barrier.

If a bonding agent is used, it shall be compatible with the repair material.

930.05.02 Anchors

Anchors for the attachment of the welded steel wire fabric to the concrete surface shall be galvanized according to ASTM A153 and be of adequate length and strength to resist a pull-out force of 1.0 kN.

930.05.03 Concrete

The concrete shall be according to OPSS 1350 with the following modifications:

a) The minimum specified 28-Day compressive strength shall be 30 MPa, except for silica fume overlays which shall be 40 MPa.

b) Coarse aggregates for overlays shall consist of a minimum of 60% crushed particles when tested according to MTO LS-607 and shall have 1.00% by mass maximum passing the 75 µm sieve when tested according to MTO LS-601. Coarse aggregate for overlays that form the bridge deck riding surface shall be composed of at least 80% siliceous rocks and minerals.

c) Linear shrinkage test data for each mix design shall be submitted for information purposes. Testing shall be carried out in accordance with LS-435 and specimens may be cast at the ready mixed plant or at the site. Laboratory testing shall be carried out by a laboratory who has participated in an MTO correlation program for linear shrinkage.

d) For concrete patches where the longest dimension, width or length, of individual patches is less than 400 mm, a proposal may be submitted to the Contract Administrator for approval to use a proprietary patching material. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions.

e) SCC will be considered on an individual project basis for patches and refacing subject to the Contract Administrator's approval. If permitted for use, SCC shall be according to the ministry's current specification for SCC. A copy of the specification can be obtained from the Ministry's Material Engineering and Research Office, 1201 Wilson Avenue, Downsview, M3M 1J8.

930.05.04 Drainage Tubes

Rigid polyvinyl chloride (PVC) drainage tubes shall be according to CSA C22.2 No. 211.2. Galvanized steel drainage tubes shall be according to ASTM A53/A53M and galvanizing shall be according to ASTM A123.

930.05.05 Forms

Forms shall be according to OPSS 919, with the exception that all forms shall be medium density overlay plywood.

930.05.06 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry's list of concrete patching materials.

930.05.07 Tie Wire

Tie wire shall be according to OPSS 905.

930.05.08 Welded Steel Wire Fabric

Welded steel wire fabric shall be welded galvanized steel and shall be according to CSA G30.5. Galvanizing shall be according to ASTM A123.

930.05.09 Water

Water used for curing, fog-misting of concrete, pre-soaking of burlap, and bonding agent shall be according to OPSS 1302.

930.06 EQUIPMENT

930.06.01 General

The following equipment shall be according to OPSS 904:

a) Bridge deck finishing machine, screed rails, screed rail chairs, and work bridges used for overlays.

b) Consolidating equipment.

c) Hand finishing tools.

d) Straight edges.

930.06.02 Buggies

Buggies used for transporting and placing the concrete may be hand operated or motorized. Motorized concrete buggies shall have a capacity no greater than 0.5 m3.

930.06.03 Compressor - Air Blasting

The compressed air shall be clean, dry, and free from oil residue and other contaminants when tested according to ASTM D4285.

930.06.04 Fog Misting Equipment

Fog misting equipment shall be provided for the curing of the silica fume concrete overlays. Hand held fogging wands shall be used.

A fogging system mounted on the finishing machine may also be used, provided it does not result in dripping or accumulation of water on the concrete surface.

930.06.05 Form and Pump Placement Method Equipment

When the form and pump placement method is specified in the Contract Documents, the pump shall be a positive displacement type pump and shall be capable of delivering adequate volumes of concrete to maintain a continuous placement.

930.06.06 Sawing Equipment - Overlays

The sawing equipment shall be self-propelled and capable of sawing the concrete overlay full depth in one pass.

930.07 CONSTRUCTION

930.07.01 General

Typical locations and areas of repair are as shown on the Contract Drawings; however, the actual locations and extent of repair shall be as determined during the layout of the repair areas according to OPSS 928 and as directed by the Contract Administrator.

930.07.02 Operational Constraints

The Contract Administrator shall be notified of the intent to place the overlay, concrete patches, or concrete refacing 1 Business Day prior to the commencement of the placing operation. The work shall not proceed until the concrete surface preparation has been completed and form PH-CC-736 has been received and signed by the Contract Administrator.

Construction equipment shall be permitted on the bridge deck or other concrete components, provided that:

a) Contamination by oil or other deleterious substances is prevented.

b) Equipment vehicles and runways are not supported by steel reinforcement.

c) Only the finishing machine and buggies used to place concrete are allowed on the abrasive blast cleaned portions of the deck or other concrete components. No other vehicles or equipment, including concrete ready mix trucks shall be permitted.

d) Heavy vehicles such as concrete ready mix trucks or dump trucks shall not be permitted on any portion of the deck, within a span, once concrete removals within the deck have commenced in that span.

No construction vehicles, equipment, or traffic, with the exception of sawcutting equipment shall be permitted on the finished surface of the overlay, patches, and on deck surface directly over soffit patches or refacing until the curing and cold weather protection period has been completed and a minimum compressive strength of 25 MPa has been attained.

Prior to seasonal shutdown, operations shall be scheduled in such a manner to ensure that overlays, concrete patches, and concrete refacing are completed in all areas where concrete removal has commenced. No steel reinforcement shall be left exposed during seasonal shutdown.

930.07.03 Normal Concrete Overlay
Silica Fume Concrete Overlay

930.07.03.01 Minimum Thickness of Overlay

The thickness of the overlay shall be according to the requirements of the Contract Drawings with no areas less than 45 mm in thickness.

930.07.03.02 Surface Preparation

All concrete surfaces against which new concrete is to be placed shall be clean, sound and free from loose or unsound fragments, coatings and any other foreign substances or debris, and shall be sufficiently rough to ensure that a full bond is developed with the new concrete.

A bonding agent may be used. The Contract Administrator shall be notified in writing whether a bonding agent is to be used and, if so, the bonding agent shall be identified.

The portion of curb face, barrier wall or parapet wall, and all existing concrete surfaces which have not been scarified, against which new concrete is to be placed, shall be uniformly roughened by means of scabbling, chipping, or bush hammering. A surface profile of 5 ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All concrete surfaces and steel reinforcement to receive the overlay shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air, except where anode mesh is to be used.

When anode mesh is required, the concrete surface shall be pressure washed with water using a pressure not less than 10 MPa with the anode mesh in place. The pressure washing shall take place immediately prior to pre-wetting. All debris resulting from drilling of anchor holes and other accumulated dirt adhering to the anode or concrete surfaces shall be removed.

All concrete surfaces to receive an overlay shall be pre-wetted and continuously maintained in a wet condition for a minimum period of 6 hours immediately prior to the application of the concrete overlay or bonding agent when used. Excess water shall be removed from the surface using compressed air immediately prior to the application of the bonding agent or concrete overlay.

930.07.03.03 Placing of Screed Rails

Supports for the screed rails shall be installed outside the area to be overlaid or waterproofed. The screed rails shall be continued beyond the deck, at each end, to a length that will enable the finishing machine to be driven beyond the end of deck.

930.07.03.04 Dry Run

A dry run shall be made to verify that the minimum thickness of the overlay can be achieved, in the presence of the Contract Administrator, prior to each placing operation.

The Contract Administrator shall be notified at least 1 Business Day in advance of a dry run. When the dry run indicates that an unsatisfactory thickness will result, the screed rails shall be adjusted in order to obtain the minimum thickness and the dry run repeated in the area of screed rail adjustment.

For silica fume concrete overlays, the ability to successfully fog mist shall be demonstrated to the Contract Administrator at the time of the dry run. The same equipment and process shall be used to fog mist the overlay.

930.07.03.05 Placing of Concrete

The placing of concrete shall be according to OPSS 904 with the following modifications:

a) Concrete shall not be placed when the ambient air temperature or existing concrete surface temperature is below 10°C or likely to fall below 10°C, or is above 30°C or likely to rise above 30°C throughout the duration of the concrete placing operation.

   Prior to placing new concrete, it shall be demonstrated to the Contract Administrator that the substrate temperatures meet the Contract requirements, by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

b) Concrete shall not be placed adjacent to any new concrete less than 48 hours old. If the ambient air temperature falls below 10°C within the first 48 hours after placement of concrete, the 48 hour time requirement shall be extended to 96 hours.

   In addition, for staged overlay construction, concrete shall not be placed adjacent to any new concrete having a compressive strength less than 20 MPa.

c) All concrete overlay 3 m or wider shall be placed with bridge deck finishing equipment.

d) Any concrete or bonding agent deposited in areas other than the intended point of discharge shall be removed immediately.

e) Unless otherwise specified in the Contract Documents, concrete for partial depth removal areas shall be placed at the same time as the overlay. Concrete for full depth removal areas shall be placed prior to placing the overlay and left with a rough surface finish.

f) Cold joints shall not be permitted.

930.07.03.06 Construction Joints

Construction joints shall be permitted only where shown in the Contract Drawings or in the case of unexpected interruptions during the placing operation, as directed by the Contract Administrator.

All construction joints shall be formed using bulkheads. The height of the bulkhead shall match the thickness of the overlay.

The edge and face created by the bulkhead shall be a clean vertical face free from any defects such as honeycombing or spalls. If the construction joint formed by the bulkhead is deemed unacceptable by the Contract Administrator, a new construction joint shall be created by sawcutting back to a limit where the quality of concrete is acceptable to the Contract Administrator.

930.07.03.07 Surface Finish

The surface finish shall be according to OPSS 904.

930.07.03.08 Surface Tolerance

The surface tolerance shall be according to OPSS 904.

930.07.03.09 Surface Texture

Where the surface of the overlay forms the driving surface of the bridge deck, the surface shall be given a texture with a wire broom or comb having a single row of tines. The required texture shall be transverse grooves which may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 mm to 4.5 mm. The texture shall extend uniformly to within 300 mm of the curb or barrier wall or parapet wall.

930.07.03.10 Curing

Normal concrete overlay shall be cured according to the requirements for Curing with Burlap and Water clause of OPSS 904 for a minimum curing period of 4 Days, except that for concrete subjected anytime to cold weather during the first 96 hours after concrete placement, the curing period shall be extended to 7 Days.

Silica fume concrete overlay shall be cured according to the requirements for high performance concrete (HPC) of OPSS 904 for a minimum curing period of 7 Days.

Where waterproofing is to be applied to an overlay following curing with burlap and water, the overlay shall be air dried for at least 72 hours prior to the application of waterproofing.

930.07.04 Concrete Patches, Formed Surface
Concrete Patches, Unformed Surface
Concrete Patches, Form and Pump
Concrete Refacing
Concrete Refacing, Form and Pump

930.07.04.01 Surface Preparation

All concrete surfaces against which new concrete is to be placed shall be clean, sound and free from loose or unsound fragments, coatings, and any other foreign substances or debris and shall be sufficiently rough to ensure that a full bond is developed with the new concrete.

A bonding agent may be used. The Contract Administrator shall be notified in writing whether a bonding agent is to be used and, if so, the bonding agent shall be identified.

All existing concrete surfaces against which new concrete is to be placed shall be uniformly roughened by means of scabbling, chipping, or bush hammering. A surface profile of 5 ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All concrete surfaces and steel reinforcement to receive new concrete shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface of the repair area by using compressed air.

The surface of the existing concrete shall be pre-wetted and continuously maintained in a wet condition for a period of 6 hours immediately prior to placing any new concrete. Prior to placing concrete, excess water shall be removed from the surface using compressed air.

930.07.04.02 Placement of Welded Steel Wire Fabric

When welded steel wire fabric is specified in the Contract Documents, it shall not be installed until after the concrete surface and exposed steel reinforcement in the repair area have been abrasive blast cleaned. The welded steel wire fabric shall not be abrasive blast cleaned at any time.

Where there is no exposed steel reinforcement, the wire fabric shall be fastened to the concrete with anchors placed no further than 600 mm apart, in a grid pattern.

Where steel reinforcement is exposed, the wire fabric shall be securely fastened to the steel reinforcement by tie wires placed no further than 600 mm apart, in a grid pattern. When the exposed steel reinforcement is not capable of providing rigid support for the wire fabric, anchors shall be used to support the wire fabric.

The wire fabric shall be installed flat, tight, and at the locations shown in the Contract Drawings using spacers and anchors. The edges of adjoining wire fabric shall overlap by two-wire spacing plus 100 mm. The wire fabric shall be kept clean of any contamination that could reduce the bond of the repair material to the wire surface.

930.07.04.03 Installation of Anchors and Dowels

Holes for anchors and dowels shall be drilled into the concrete at the location and spacing as specified in the Contract Documents. They shall be installed in such a way as to not cause delamination or other damage to the surrounding concrete. Each anchor used to fasten the welded steel wire fabric into the concrete shall be installed to resist a pull out force of at least 1.0 kN at either sides of the concrete interface.

930.07.04.04 Formwork and Falsework

The erection and removal of formwork and falsework shall be according to OPSS 919 and it shall be designed to retain the concrete and withstand the placement pressures. The formwork shall be placed to provide the specified cover to steel reinforcement or welded steel wire fabric, or both, as specified in the Contract Documents. When this results in over-building of the existing concrete surface, a 1H:1V slope shall be provided to meet the existing surface at the edges of the repair area. The perimeter of the formwork shall be sealed to be grout-tight. Vent holes shall be installed at the highest locations.

930.07.04.05 Placing of Concrete

The placing of concrete shall be according to OPSS 904 with the following modifications:

a) Concrete shall not be placed when the ambient air temperature or existing concrete surface temperature is below 10°C or likely to fall below 10°C or is above 30°C or likely to rise above 30°C throughout the duration of the concrete placing operation.

   Prior to placing new concrete, it shall be demonstrated to the Contract Administrator that the substrate temperatures meet the Contract requirements by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

b) Concrete shall not be placed adjacent to any new concrete less than 48 hours old. If the ambient air temperature falls below 10°C within the first 48 hours after placement of concrete, the 48 hour time requirement shall be extended to 96 hours.

c) For form and pump method, the port arrangement and pumping procedures shall be designed to ensure that requirements of this specification are met.

d) Cold joints shall not be permitted.

930.07.04.06 Construction Joints

Construction joints in concrete shall be permitted at the locations shown on the Contract Drawings and shall be according to OPSS 904. Any additional construction joints required to suit the construction operation and to meet the specified crack control criteria shall be subject to approval by the Contract Administrator.

930.07.04.07 Surface Finish

The surface finish shall be according to OPSS 904.

930.07.04.08 Surface Tolerance

The surface tolerance shall be according to OPSS 904.

930.07.04.09 Curing

930.07.04.09.01 General

Normal concrete shall be cured for a minimum period of 4 Days, except that for concrete subjected anytime to cold weather during the first 96 hours after concrete placement the curing period shall be extended to 7 Days.

930.07.04.09.02 Unformed Surfaces

Concrete shall be cured for the full duration of the curing period according to the Curing with Burlap and Water clause in OPSS 904. The burlap and the moisture vapour barrier shall then be removed and the concrete permitted to air dry for not less than 72 hours prior to any application of tack coat for waterproofing, where applicable.

930.07.04.09.03 Formed Surfaces

930.07.04.09.03.01 General

All exposed concrete surfaces of formed components shall be cured as specified in the Unformed Surfaces clause.

930.07.04.09.03.02 Concrete Patches, Formed Surface
Concrete Patches, Form and Pump

Curing shall be according to the following:

a) If the formwork is left in place for the duration of the curing period, no additional curing shall be required.

b) Where the formwork is to be removed within the specified curing period, curing shall be applied as specified in the Unformed Surfaces clause, curing shall be applied immediately after removal of the formwork and remain in place until the end of the curing period. Under no circumstance shall the concrete be left uncured for more than 2 hours during the removal of formwork.

930.07.04.09.03.03 Concrete Refacing
Concrete Refacing, Form and Pump

Burlap and water shall be applied immediately to the top of all exposed concrete surfaces, within 2 to 4 m of the finishing operation. The burlap shall be soaked for 24 hours prior to placing and shall be kept continuously wet by means of an operating soaker hose placed along the top of the component being refaced. The soaker hose shall be placed immediately after the concrete has set and its operation shall not cause fines to be washed out.

Forms for all surfaces, except soffit for structural components, shall be removed within 16 to 24 hours of concrete placement, unless the Contractor is unable to remove the forms due to structural concerns. All concrete surfaces shall be immediately covered with wet burlap and moisture vapour barrier for the remainder of the minimum curing period according to the requirements of Curing with Burlap and Water clause in OPSS 904. Under no circumstance shall the concrete be left uncured for more than 2 hours during the removal of the formwork.

Forms for soffit of structural components including decks, pier caps, beams, and arch ribs shall not be removed until the full curing time has elapsed.

930.07.05 Cold Weather Protection

930.07.05.01 General

Concrete shall be protected during cold weather. The protection system shall be designed for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required.

Regardless of ambient air temperature, overlays shall be moist cured with burlap and water at all times. During cold weather, burlap shall be prevented from freezing.

930.07.05.02 Control of Temperature and Temperature Difference

During cold weather, the temperature of the concrete shall be monitored and controlled according to the Control of Temperature and Temperature Difference subsection in OPSS 904, with the following exceptions:

a) Thermocouple wires shall be embedded near the concrete surface in a minimum of 4 locations for each Day of concrete placement, as directed by the Contract Administrator. Thermocouples for monitoring ambient air temperature shall be installed in the shade close to the surface of the concrete at a minimum frequency of 1 thermocouple for each Day of placement.

b) For cold weather conditions, protection of concrete shall, at a minimum, be as shown in Table 1. Protective measures shall be increased based on consideration of the specific type of rehabilitation in order to comply with the specified temperature constraints, as required.

c) The cold weather protection shall be gradually removed or reduced in such a manner that the maximum allowable drop of concrete temperature for each 24 hour period as shown in Table 1 is not exceeded. The protection shall not be totally removed nor shall the concrete be fully exposed to the air until the average concrete temperature is within 10°C of the air temperature.

930.07.06 Material Sampling and Testing

930.07.06.01 Plastic Concrete Testing

The sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350 with the exception that the minimum frequency of testing shall be one test from each load of concrete. Results shall be recorded and shall be submitted to the Contract Administrator, upon request.

930.07.06.02 Early Strength Determination

Where early loading of concrete is proposed or anticipated, sets of cylinders for testing for early strength determination shall be prepared according to OPSS 904.

930.07.06.03 Samples for Compressive Strength, Air Void System Parameters and Rapid Chloride Permeability - Acceptance Testing

The Contractor shall be responsible for sampling and transportation of samples for acceptance testing of compressive strength, air void system, and rapid chloride permeability by the Owner according to OPSS 1350.

930.07.06.03.01 Samples for Acceptance Testing Where Rehabilitation Involves the Use of Anode Mesh Cathodic Protection

Cylinders for acceptance testing of compressive strength shall be according to OPSS 1350.

Where anode mesh is used, cores shall not be required and cylinders shall be cast for determination of air void system and rapid chloride permeability. One cylinder shall be made for determination of air void system parameters to represent each 300 m2 of surface area of overlay and for each 100 m^2 of surface area of patches and refacing placed.

For silica fume overlays, two additional cylinders shall be made for determination of rapid chloride permeability to represent each 300 m^2 of surface area of overlay placed. One cylinder shall be used for acceptance testing and the remaining cylinder shall be retained for referee testing.

The cylinders shall be 100 mm diameter × 200 mm long and shall be made, field cured, and transported according to the Test Cylinders clause in OPSS 1350.

930.07.06.04 Tensile Bond Strength

The following shall be marked to facilitate the selection of testing locations and avoid damage to the embedded materials due to coring:

a) For rehabilitation involving use of anode mesh cathodic protection in overlay, the locations of anode distribution bars, wiring, and embedded hardware.

b) For rehabilitation involving use of glass fiber reinforced polymer (GFRP) reinforcing, the reinforcing bar locations.

Application of tack coat, where applicable, shall not be carried out until the testing of tensile bond strength is completed.

930.07.06.05 Filling of Core Holes

Filling of core holes shall be according to OPSS 1350.

930.07.07 Remedial Work

Remedial work shall be carried out as shown in Table 2.

Treatment for deck with waterproofing and paving shall not begin until the specified curing period and the air drying period has elapsed. For all other exposed components, the treatment shall not begin until a minimum period of 28 Days has elapsed after placement of concrete.

Repair of cracks shall be according to OPSS 932. Alternatively, a proposal for repair may be submitted to the Contract Administrator for review to show that the repair method and material shall be able to restore the structural integrity of the concrete across the cracks. The inspection and monitoring of cracks shall continue up to the date of waterproofing or completion of the Work, whichever is later.

The application of tack coat for waterproofing shall not proceed until all defects have been addressed and remedial work accepted by the Contract Administrator.

930.07.08 Modification of Deck Drains

Modification of deck drains shall be made prior to waterproofing the deck.

930.07.09 Drainage Tubes in Deck

Installation of drainage tubes shall be made prior to waterproofing the deck.

930.07.10 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

930.08 QUALITY ASSURANCE

930.08.01 Testing - Tensile Bond Strength

The Contract Administrator shall use a covermeter to locate steel reinforcement prior to testing in order to avoid coring through the steel and shall perform the sampling and testing of cores from overlays, concrete patches, and concrete refacing to determine tensile bond strength.

A lot shall consist of the total quantity of concrete patches, concrete refacing, or overlay for each item, except for the following where tensile bond shall not be measured:

a) When the total measured area of concrete patches on a structure is less than 20 m^2.

b) When the total area of concrete refacing on a structure is less than 20 m^2.

c) In circular columns with spiral reinforcement.

Each lot shall be divided into sublots as follows:

a) Sublots for overlays shall be approximately equal in size and not greater than 300 m^2. Separate sublots are required for each overlay placement.

b) Sublots for concrete patches shall not be combined with areas of concrete refacing for determining sublots. Sublots shall be approximately equal in size and not greater than 100 m^2. Work on different structures shall not be combined in the same sublot.

c) Soffit repairs shall be a separate sublot and a sublot shall not be greater than 100 m^2.

The tensile bond strength testing shall be carried out on 3 in-situ cores taken within 1 m of each other for each sublot. The core locations shall be randomly selected by the Contract Administrator. Additional testing shall not be permitted.

The cores shall be obtained by the Contract Administrator according to CSA A23.2-14C. Cores shall be 100 mm in diameter and extend into the parent concrete to the depth as specified in LS-430. The testing shall be according to LS-430 and shall be carried out when the concrete is 7 to 10 Days of age. The equipment used to measure the tensile bond strength shall be equipped with a maximum load indicator.

If a core comes loose during coring operation, another core shall be obtained within 300 mm of the original core location.

If failure occurs in the epoxy adhesive and the specified strength of 1.0 MPa has not been reached, the test shall be repeated within 300 mm of the original core location. If a failure occurs fully within the parent concrete, this shall be considered a valid result, unless the Contractor has been directed to leave unsound concrete in place. Retesting is not required when the specified strength of 1.0 MPa has been achieved

Individual test results shall be forwarded to the Contractor, as they become available.

930.08.02 Inspection After Curing

The Contract Administrator shall inspect the Work to determine if the completed work contains any of the following defects:

a) Areas of debonding.

b) Honeycombed areas, spalls, and cold joints.

c) Cracks requiring remedial work as shown in Table 2.

930.08.03 Acceptance

930.08.03.01 Concrete Compressive Strength, Air Void System in Hardened Concrete or Rapid Chloride Permeability for Silica Fume Overlays

Acceptance, referee testing and referee testing cost of concrete compressive strength, air void system in hardened concrete, and rapid chloride permeability for silica fume overlays shall be according to OPSS 1350.

930.08.03.02 Tensile Bond Strength

For a sublot to be acceptable, the average tensile bond strength of the sublot shall be a minimum of 1.0 MPa. Sublots with average tensile bond strength less than 1.0 MPa and more than or equal to 0.8 MPa shall be accepted with payment reduction. The payment reduction factor (Pri) for the tensile bond strength testing for each sublot shall be calculated based on the following equation:

$$Pr_i = 1.25 (1 - B)$$

Where:

B = The average tensile bond strength (MPa) for each sublot. For the purpose of calculating the payment reduction factor, a value of 1.0 MPa shall be used for B when the average tensile bond strength is greater than 1.0 MPa.

i = Sublot number

The payment reduction, Pr, for the lot is calculated by one of the following equations:

For the concrete patches, concrete refacing, place concrete overlay, and place silica fume concrete overlay items, the following equation shall be used:

$$Pr = \text{Tender Unit Price} \times [(Pr_1 \times LQ_1) + (Pr_2 \times LQ_2) \ldots (Pr_n \times LQ_n)]$$

Where:

Pri = The payment reduction for sublot i

LQ_i = Quantity for sublot i (m^3)

n = The total number of sublots

For the finish and cure concrete overlay and finish and cure silica fume concrete overlay items, the following equation shall be used:

$$Pr = \frac{\text{Lump Sum} \times [(Pr_1 \times SA_1) + (Pr_2 \times SA_2) \ldots (Pr_n \times SA_n)]}{SA_T}$$

Where:

Pri = The payment reduction for sublot i
SA_i = Surface area for sublot i (m^2)
SA_T = Total surface area of the lot (m^2)
n = The total number of sublots

For the purpose of calculating the payment reduction for concrete overlays, the Pr shall be applied to both place concrete overlay and finish and cure concrete overlay items.

For the purpose of calculating the payment reduction for silica fume concrete overlays, the Pr shall be applied to both place silica fume concrete overlay and finish and cure silica fume concrete overlays items.

930.08.03.03 Acceptance at the Completion of Work

The Contract Administrator shall reject all or a portion of the sublot based on:

a) The presence of debonding, honeycombed areas, spalls and cold joints.

b) Cracks as shown in Table 2.

c) Average tensile bond strength less than 0.8 MPa.

d) Any work that does not meet the requirements of this specification and the acceptance requirements of OPSS 1350.

e) Unsatisfactory completion of remedial work associated with surface tolerance, surface finish, cracks, or any other deficiencies.

930.08.03.04 Performance During General Warranty Period

In addition to the acceptance requirements stated herein, concrete in the structure shall meet the requirements as shown in Table 2 during and up to the end of the general warranty period.

930.09 MEASUREMENT FOR PAYMENT

930.09.01 General

For all types of overlays, there shall be no measurement for the following:

a) Concrete produced in excess of that required for the placing operation.

b) Quantity of bonding agent.

For construction joints in overlay that do not meet the requirements specified in this specification and is deemed unacceptable by the Contract Administrator, the portion of overlay removed shall be deducted from the volume indicated on the delivery ticket.

No measurement shall be made for areas of new overlays, concrete patches, and concrete refacing that were removed according to the requirements of the Remedial Work subsection.

930.09.02 Actual Measurement

930.09.02.01 Place Concrete Overlay
Place Silica Fume Concrete Overlay

Measurement shall be by the volume of concrete placed, including concrete placed in partial depth removals, in cubic metres by delivery ticket. Deductions shall be made for the following:

a) Concrete produced in excess of that required for the placing operation.

b) The portion of the overlay that is sawcut back and removed at the construction joint.

c) The portion of concrete removals not approved by the Contract Administrator.

The total volume shall be calculated to the nearest cubic metre.

930.09.02.02 Concrete Patches, Formed Surface
Concrete Patches, Unformed Surface
Concrete Patches, Form and Pump
Concrete Refacing
Concrete Refacing, Form and Pump

930.09.02.02.01 By Volume

Measurement shall be by the volume of concrete placed in cubic metres.

The volumes shall be calculated by multiplying each area to be patched by the average depth. Depths shall be taken on a grid system to best describe the profile at the particular area. The Contract Administrator, in the presence of the Contractor, shall take a minimum of 3 measurements for each removal area or 10 for every m^2, after concrete removal is completed by placing a straight edge across the removal area and measuring the depth from the straight edge to the concrete.

The depths shall be measured and averaged to the nearest millimetre.

No measurement shall be made for concrete required to fill localized areas behind the second layer of steel reinforcement.

The total volume shall be calculated to the nearest 0.1 m^3.

930.09.02.03 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified.

930.09.02.04 Drainage Tubes in Deck

For measurement purposes, a count shall be made of the number of drainage tubes placed.

930.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

930.10 BASIS OF PAYMENT

930.10.01 Modification of Deck Drains - Item
Drainage Tubes in Deck - Item
Place Concrete Overlay - Item
Place Silica Fume Concrete Overlay - Item
Finish and Cure Concrete Overlay - Item
Finish and Cure Silica Fume Concrete Overlay - Item
Concrete Patches, Formed Surface - Item
Concrete Patches, Unformed Surface - Item
Concrete Patches, Form and Pump - Item
Concrete Refacing - Item
Concrete Refacing, Form and Pump - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments as specified in the Contract Documents. Payment at the Contract price for the above tender items shall also include abrasive blast cleaning of the concrete surface for concrete patches and concrete refacing. Payment for abrasive blast cleaning of steel reinforcement and the concrete surface to receive an overlay shall be administered according to OPSS 929.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the concrete patching and concrete refacing items shall include full compensation for all labour, Equipment, and Material to do the work, including provision of access.

No payment shall be made for normal concrete, silica fume concrete or self-consolidating concrete or both required to patch, reface, or overlay areas of concrete removal where the removal was not approved by the Contract Administrator.

TABLE 1
Minimum Cold Weather Protective Measures

Anticipated Minimum Air Temperature (°C)	Protective Measure
+10 to +6	PM2 - Cover concrete with insulation having an R-Value of 0.67.
+5 to 0	PM3 - Cover concrete with insulation having an R-Value of 1.33.
-1 to –5	PM4 - Cover concrete with insulation having an R-Value of 2.00.
-6 and lower	PM5 - House and heat according to the Housing and Heating clause of OPSS 904.
Maximum Allowable Drop in Concrete Temperature / 24 hours	15 °C

Notes:

1) All R-Values are metric.

2) The conversion factor from metric to imperial unit is: Metric R value × 5.678 = Imperial R value.

TABLE 2
Performance Requirements at Time of Construction and During Warranty Period

	Test Method	Performance Requirements	Consequence of Non-Conformance
Concrete Surface Scaling	Visual inspection and assessment of severity of scaling according to Figures 1 to 6.	At the end of the warranty period, there shall be no medium or severe scaling and total area of light scaling shall be no more than 5% of the component.	Areas of medium and severe scaling shall be removed and replaced full depth. For light scaling greater than 5% of the component, the Contractor shall submit a repair proposal for approval by the ministry.
Concrete Delamination or Debonding	As described in the Structure Rehabilitation Manual.	Delaminated or debonded areas shall not be present.	Remove and replace.
Cracks	Visual inspection and measurement by means of crack comparator. Width of crack is measured at the widest point of the crack, not average width of crack. Cracks in overlays and patches to be waterproofed shall be measured after the air drying period.	For overlays and patches to be waterproofed and paved, width of cracks shall be less than 0.50 mm and linear measurement of cracks greater than 0.50 mm within 1 m^2 shall be less than 2 m.	Repair cracks greater than 0.50 mm in width according to OPSS 932, unless the linear measurement of cracks greater than or equal to 0.50 mm per m^2 exceeds 2 m. If the linear measurement of cracks greater than 0.50 mm in width exceeds 2 m per m^2, remove and replace.
		For exposed overlays, refacing and patches, width of cracks shall be less than 0.30 mm and linear measurement of cracks greater than 0.30 mm within 1 m^2 shall be less than 2 m.	Repair cracks greater than 0.30 mm in width according to OPSS 932, unless the linear measurement of cracks greater than or equal to 0.30 mm per m^2 exceeds 2 m. If the linear measurement of cracks greater than 0.30 mm in width exceeds 2 m per m^2, remove and replace.
Spalls, Exposed Reinforcement, Honey-Combing, and Other Observed Unanticipated Defects and Deterioration	Visual inspection.	Spalls, exposed reinforcement, honey-combing, or other observed defects and deterioration shall not be present at the end of the warranty period.	Remove and replace.

Note:

A) Where the area failing to meet the performance requirement is a large proportion of the repair area, the entire repair shall be removed and replaced.

FIGURE 1
Example of Light Scaling

FIGURE 2
Example of Light Scaling

FIGURE 3
Example of Medium Scaling

FIGURE 4
Example of Medium Scaling

FIGURE 5
Example of Severe Scaling

FIGURE 6
Example of Severe Scaling