



**CONSTRUCTION SPECIFICATION FOR  
REPAIRING CONCRETE PAVEMENT AND CONCRETE BASE**

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**TABLE OF CONTENTS**

<b>366.01</b>	<b>SCOPE</b>
<b>366.02</b>	<b>REFERENCES</b>
<b>366.03</b>	<b>DEFINITIONS</b>
<b>366.04</b>	<b>DESIGN AND SUBMISSION REQUIREMENTS</b>
<b>366.05</b>	<b>MATERIALS</b>
<b>366.06</b>	<b>EQUIPMENT</b>
<b>366.07</b>	<b>CONSTRUCTION</b>
<b>366.08</b>	<b>QUALITY ASSURANCE</b>
<b>366.09</b>	<b>MEASUREMENT FOR PAYMENT</b>
<b>366.10</b>	<b>BASIS OF PAYMENT</b>
<b>APPENDICES</b>	<b>Not Used</b>

**366.01 SCOPE**

This specification covers the requirements for full depth and partial depth repairs using conventional concrete, and full-depth fast-track repairs, to concrete pavement and concrete base.

**366.01.01 Specification Significance and Use**

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

### **366.01.02 Appendices Significance and Use**

Appendices are not for use in provincial Contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner.

Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their Contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

### **366.02 REFERENCES**

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

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

#### **Ontario Provincial Standard Specifications, Construction**

OPSS 350	Concrete Pavement and Concrete Base
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

#### **Ontario Provincial Standard Specifications, Materials**

OPSS 1002	Aggregates – Concrete
OPSS 1010	Aggregates – Base, Subbase, Select Subgrade and Backfill Material
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1441	Load Transfer Assemblies

#### **Ontario Ministry of Transportation Publications**

MTO Laboratory Testing Manual:

LS-101	Procedures for Calculating Percent Within Limits
LS-410	Method of Test for Compressive Strength of Drilled Cores
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
LS-435	Method of Test for Linear Shrinkage of Concrete
LS-447	Method of Test for Falling Weight Deflectometer

Designated Sources for Materials (DSM)

### CSA Standards

A23.1/A23.2-014	Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete
A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens
A23.2-9C	Strength of Cylindrical Concrete Specimens
A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing

### ASTM International

C 171-92	Sheet Materials for Curing Concrete
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### American Association of State Highway and Transportation Officials (AASHTO)

M 182 –89	Standard Specification for Burlap Cloth made from Jute or Kenaf
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## 366.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

**Autogenous Cylinders** means cylinders used for estimating compressive strength of concrete in fast-track repair areas. These cylinders are stored in insulated curing containers at which the elevated curing temperature is obtained from heat of hydration of the cement.

**Cold Weather** means those conditions when the air temperature is at or below 5 °C, or when the air temperature is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

**Diamond Grinding** means altering the profile and texture of a concrete surface by utilizing grinding equipment that employs diamond tip blades.

**Fast-track Repair** means a process in which a section of concrete pavement or concrete base is closed to traffic, concrete is removed and repairs are completed and the section re-opened to traffic within a specified time period of 24 hours or less.

**Hot Weather** means those conditions when the air temperature is at or above 28 °C, or 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.

**Partial Depth Repairs** means repair areas in the concrete pavement or concrete base which have a minimum depth of 50 mm to a maximum depth of one-third the thickness of the existing concrete slab.

**Staged Repair** means a repair area which cannot be repaired in one complete operation due to traffic or construction sequence requirements, and must be completed in separate stages. Each stage shall be a minimum of one lane in width and 2 m in length.

**Working Cracks** means full depth cracks which are subject to horizontal or vertical movement under normal service conditions.

#### **366.04 DESIGN AND SUBMISSION REQUIREMENTS**

##### **366.04.01 Design Requirements**

###### **366.04.01.01 Concrete Mix Design**

The concrete mix shall be designed to provide adequate strength and durability for the intended use and to meet the requirements specified in the Contract Documents.

##### **366.04.02 Submission Requirements**

###### **366.04.02.01 Concrete Mix Design**

The concrete mix design(s) shall be submitted according to OPSS 1350 with the following addition:

- a) Test data for linear shrinkage tested according to LS-435, shall be submitted to the Contract Administrator within 40 days of the mix design submission, for information purposes only. Concrete specimens may be obtained from a laboratory batch or sampled in the field.

###### **366.04.02.02 Calibration Charts and Autogenous Cylinder Method for Fast-track Repairs**

The autogenous cylinder method shall be used for determination of strength prior to opening to traffic for all fast-track repairs. The minimum length of time for which calibration charts shall be developed shall be the period of lane closure specified in the Contract Documents.

The size, preparation and testing of cylinders shall be according to the Early Strength Determination of Fast-track Repairs section in the Construction section of this specification.

For the development of the calibration chart, testing of cylinders for compressive strength shall commence no later than 3 hours after the cylinders are cast, and testing shall continue at a minimum frequency of every 30 minutes for the length of time of the lane closure. One set of two cylinders shall be tested at each time interval. A thermocouple wire shall be installed in one of the cylinders in each set, and temperature shall be recorded at a minimum of every 30 minutes after casting until the time of testing.

The following information shall be submitted to the Contract Administrator at the time of submission of the concrete mix design:

- a) Calibration chart indicating compressive strength versus temperature.
- b) Calibration chart indicating temperature versus time.
- c) Ambient air temperature during development of the calibration charts.

The above data shall be accompanied by a covering letter, signed by an Engineer, identifying the curing method and test method, and detailing the development of the calibration chart.

If the ambient air temperature at time of placement differs from the ambient air temperature during the development of the calibration charts by more than 10 °C, new calibration charts shall be submitted.

In the event that field performance or conditions are no longer representative of the conditions under which the submitted calibration charts were developed, a new mix design and charts shall be resubmitted prior to proceeding with concrete repairs.

#### **366.04.02.03 Method of Removal of Existing Concrete**

A description of the method to be used to remove the existing concrete shall be submitted to the Contract Administrator at least two weeks prior to the start of the work. The description shall comply with the requirements in the Concrete Removal subsection and include the sawcutting and removal process, equipment, and disposal.

#### **366.04.02.04 Chipping Hammers**

The manufacturer's published specifications on the chipping hammers shall be submitted to the Contract Administrator one week prior to the commencement of the partial depth removal operation.

#### **366.04.02.05 Temperature Control Plans**

##### **366.04.02.05.01 Cold Weather**

Temperature control plans for all repairs except fast-track repairs, shall be submitted according to OPSS 904 in the event of cold weather conditions.

##### **366.04.02.05.02 Hot Weather**

For concrete subject to hot weather, a description of the methods to be used to control the temperature of the concrete shall be submitted to the Contract Administrator 7 Days prior to placement.

### **366.05 MATERIALS**

#### **366.05.01 Admixtures for Concrete**

Use of admixtures shall be according to the Use of Admixtures clause of OPSS 1350 with the following exceptions and additions:

- a) For fast-track repairs, superplasticizer may be used and may be added at the plant or site. Testing of slump prior to addition of superplasticizer is not required.
- b) For fast-track repairs, calcium chloride based accelerator may be used. When used, it shall be measured accurately to ensure a consistent dosage for each load, and it shall be added and mixed in a manner to ensure consistent distribution throughout the load.

Type S admixtures listed on the DSM may be used and concrete containing Type S admixtures shall meet all requirements of this specification.

#### **366.05.02 Bond Breaker for Dowel Bars and Load Transfer Devices**

Dowel bars and load transfer devices shall be shop coated with RC-250, Tectyl 506, or an Owner-approved equivalent. Application of a shop applied bond breaker does not apply to dowels which are grouted into existing concrete.

### **366.05.03                      Bonding Agent**

Bonding agent shall consist of Portland cement and fine aggregate mixed with water to form a stiff mixture. Portland cement shall be according to OPSS 1301. Fine aggregate shall be according to OPSS 1002. The consistency of the mixture shall be such that it can be applied with a stiff brush to the concrete surface in a thin even coating that will not run or puddle.

### **366.05.04                      Burlap**

Burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

### **366.05.05                      Concrete**

Materials for concrete shall be according to the Materials section of OPSS 1350 with the following exceptions and additions:

- a) The nominal maximum size of coarse aggregate shall be as specified in Table 1.
- b) The minimum 28-Day concrete compressive strength shall be 30 MPa.
- c) The compressive strength of the concrete in the repair area shall be a minimum of 20 MPa prior to opening to traffic.
- d) For partial depth concrete repairs in areas where the greatest dimension (width or length) of the repair area is less than 300 mm, a proposal to use a proprietary patching material may be submitted to the Contract Administrator for approval.
- e) The requirements of OPSS 1350 for plastic air content and rapid chloride permeability do not apply.
- f) Fast-track concrete shall not be used for partial depth repairs.
- g) For fast-track repairs, Type HE Portland cement may be used.
- h) For fast-track repairs, the maximum allowable slump including tolerance shall be 230 mm.
- i) For fast-track repairs, the temperature of concrete at the time of placing shall be less than or equal to 35 °C.

### **366.05.06                      Curing Compound**

White pigmented curing compound for concrete shall be according to OPSS 1315.

### **366.05.07                      Epoxy Adhesives**

Epoxy adhesives shall be of the type approved for horizontal dowel applications and mixed in the nozzle (cartridge). Cementitious grouts shall not be permitted for this application.

### **366.05.08                      Joint Materials**

Expansion joint filler shall be according to OPSS 1308. Joint sealant material shall be according to OPSS 369.

**366.05.09 Moisture Vapour Barrier**

Moisture vapour barrier shall be white opaque polyethylene film according to ASTM C171 and shall not be less than 100 µm thick.

**366.05.10 Proprietary Patching Materials**

Proprietary patching materials shall be from the Owner's list of acceptable concrete patching materials. The list of proprietary patching materials may be obtained from the Contract Administrator.

**366.05.11 Tie Bars, Dowel Bars and Load Transfer Devices**

Tie bars shall be deformed bars, according to OPSS 1440. Dowel bars and load transfer devices shall be according to OPSS 1441.

**366.05.12 Water**

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

**366.06 EQUIPMENT**

**366.06.01 Batching Plant and Delivery Equipment**

The batching plant shall be according to the Batching Plant subsection of OPSS 1350. Delivery equipment shall be according to the Delivery Equipment subsection of OPSS 1350.

**366.06.02 Chipping Hammer**

Chipping hammers shall be hand held and have a maximum weight of 9.0 kg prior to any handle modification, where applicable, and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and parts or model number engraved on them by the manufacturer. All information shall be clearly legible. The manufacturer's published specifications shall be the sole basis for determining air hammer weight and piston stroke.

**366.06.03 Air Compressor**

The compressor for air blasting shall have a minimum capacity of 3.5 m<sup>3</sup>/min. The compressed air shall be free from oil and other contaminants.

**366.06.04 Diamond Grinder**

When a diamond grinder is used, it shall be power-driven, self-propelled equipment specifically designed to grind and texture concrete surfaces. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall be equipped with the capability to adjust the depth, slope and cross-fall to ensure that concrete is removed to the desired dimensions and uniformly feathered and textured across the width and length of the required area. The equipment shall also include a slurry pick-up system.

**366.06.05 Gang Drill**

The gang drill shall consist of not less than three independently powered pneumatic drills. Drilling shall not damage adjacent concrete.

**366.06.06 Hand Finishing Equipment**

Floats used to finish concrete shall be made of magnesium or wood with the exception of bull floats which shall be magnesium.

**366.06.07 Placing and Finishing Equipment**

Equipment used for placing, consolidating and finishing concrete for full depth and fast-track repairs shall be a vibratory steel screed or steel cylinder screed with integral internal vibration including automatic shut-off, and shall operate on fixed forms.

For repair areas less than 3 m in length, measured in the direction of traffic, the concrete may be placed and consolidated using hand held vibrators and finished with a straightedge.

**366.06.08 Thermocouples and Dataloggers**

Thermocouples and associated instrumentation shall have an accuracy of  $\pm 1.5$  °C, shall record temperatures at time intervals not exceeding 15 minutes, and shall display the temperature.

**366.07 CONSTRUCTION**

**366.07.01 Autogenous Cylinder Method Calibration Charts**

For fast-track repairs, prior to commencement of the trial area and construction of the repairs, calibration charts shall be developed for the purpose of determining the rate of early strength development of the fast-track mix. Development of the calibration charts shall be according to the Design and Submission section.

**366.07.02 Operational Constraints**

**366.07.02.01 General**

The Contract Administrator shall be notified in writing of the intent to repair the concrete pavement or concrete base one week prior to the commencement of concrete pavement repairs.

Concrete shall not be placed when the air temperature or existing pavement surface temperature is below 5 °C, or is above 30 °C.

Vehicles shall not be permitted to drive on areas where the concrete pavement or base has been removed, in whole or part.

The concrete pavement or concrete base shall be protected from damage to the surface at all times when steel-tracked equipment is used. Traffic, other than foot traffic and rubber-tired sawing equipment, shall not be permitted on the concrete until it has attained a compressive strength of 20 MPa.

**366.07.02.02 Fast-track Repairs**

Fast-track repairs shall not be placed between October 1 and May 1. Fast-track repairs shall not be performed in cold weather conditions. Fast-track repairs shall be full depth.

Each repair location shall be completed within the time frames specified in the Contract Documents. If the repair is not progressing at a rate that will permit the opening to traffic within the specified time period,



temporary measures acceptable to the Contract Administrator shall be undertaken to allow the opening of the road to traffic. These temporary measures shall be at the Contractor's expense. A fast-track concrete repair shall replace the above temporary work during the next scheduled closure.

### **366.07.03 Concrete Removal**

#### **366.07.03.01 Full Depth and Fast-track Repairs**

Areas to be repaired with full depth removal or with fast-track repairs shall be as specified in the Contract Documents or as demarcated by the Contract Administrator. Repairs shall extend the full width of the lane. Partial lane-width repairs shall not be permitted.

The outer limits of the concrete removal area shall be sawcut full depth. Sawcuts shall extend no more than 100 mm into existing adjacent concrete that is to remain in place. Sawcuts in concrete that are to remain in place shall be filled with an epoxy resin acceptable to the Owner. Sawcutting shall not be carried out more than one week prior to the expected date of repair.

Concrete removal shall be by a lift-out method rather than breaking in place. Adjoining concrete and underlying base shall remain undisturbed. Heavy breaking equipment such as hoe rams shall not be used in the removal operation.

If during the removal, the material below the concrete pavement or base is disturbed or removed, any voids shall be filled with Granular O meeting the requirements of OPSS 1010. Compaction of the Granular O shall be by means of:

- a) A plate tamper with a minimum mass of 80 kg, or
- b) A self-propelled (walk-behind) single or tandem steel drum with a minimum static mass of 500 kg used in vibration mode.

If during the removal process the adjacent concrete in the lane is damaged or cracked due to the removal procedure, the damaged area shall be cut back full depth to sound concrete and replaced as directed by the Contract Administrator at no additional cost to the Owner. The full area shall be repaired as one continuous placement.

#### **366.07.03.02 Partial Depth Repairs**

Areas to be repaired with partial depth concrete removal shall be as demarcated by the Contract Administrator. The perimeter of the repair area shall be sawcut vertically to a depth of 25 mm. The concrete within the sawcut area shall be removed using a chipping hammer to a minimum depth of 50 mm, and to a maximum depth of one-third the thickness of the existing concrete slab, using equipment that will not damage the underlying sound concrete. Any wire mesh in the concrete shall be removed within the repair area.

In the event that the partial depth concrete removal operation reveals deterioration extending to a depth greater than one-third the thickness of the existing concrete slab, the repair shall be treated as a full depth repair or fast-track repair and concrete shall be removed according to Concrete Removals – Full Depth and Fast-track Repairs subsection. Full depth repair work shall not proceed without prior approval from the Contract Administrator.

**366.07.04                      Preparation Work**

**366.07.04.01                      Full Depth and Fast-track Repairs**

Before placing concrete on granular base, the granular immediately ahead of the concrete placing operation shall be wetted down thoroughly. The wetting down shall be carried out without leaving standing water.

**366.07.04.02                      Partial Depth Repairs**

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

Immediately prior to 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 patch to receive new concrete shall be maintained in a wet condition for a period of one hour prior to placing any new concrete. Prior to placing concrete, excess water shall be removed from the surface using compressed air.

Immediately prior to filling the repair area with concrete, a thin even coat of bonding agent shall be brushed onto all vertical and horizontal prepared surfaces against which concrete will be placed. After application of the bonding agent, any fine aggregate separated from the mixture or any excess bonding agent shall be removed from the surface of the concrete.

The bonding agent shall be applied within 30 minutes after mixing and shall not be permitted to dry prior to placing any concrete on it. In the event that the bonding agent has dried, it shall be removed and reapplied prior to concrete placement. All bonding agent or concrete deposited in areas other than the intended point of discharge shall be removed immediately.

**366.07.05                      Joints**

**366.07.05.01                      Full Depth and Fast-track Repairs**

**366.07.05.01.01                      General**

Joints for concrete pavement and concrete base shall be according to OPSS 350. Where the operation requires a staged repair, a construction joint shall be placed between stages.

**366.07.05.01.02                      Dowel Bars and Tie Bars**

Dowel bars and tie bars shall be installed at locations specified in the Contract Documents. Where reinforcement is present, dowel bars may be adjusted 25 mm horizontally and raised or lowered 10 mm, to avoid drilling through the reinforcement.

Gang drills shall be used to drill holes in the existing concrete for insertion of the dowel bars. The diameter of the drill hole shall be no more than 5 mm larger than the diameter of the dowels or tie bars. Prior to filling the drill holes, the inside surfaces of each drill hole shall be wire brushed and then cleaned using compressed air. The dowel bars and tie bars shall be secured into the existing concrete with epoxy adhesive. The epoxy adhesive shall be injected into the back of the cleaned drill hole and the dowel or tie bar, with grout retention disks attached, shall be inserted to completely encase the bars with epoxy adhesive for the full depth of the hole.

The dowel bars shall be placed mid-depth of the slab thickness specified in the Contract Documents and parallel to the longitudinal axis and the horizontal plane of the pavement with the following tolerances:

- a) Vertical Alignment:  $\pm 15$  mm along the length of the dowel bar.
- b) Horizontal Alignment:  $\pm 15$  mm along the length of the dowel bar.
- c) Side Shift: The centre of the dowel bar shall lie within  $\pm 50$  mm from the transverse joint.
- d) Depth:
  - i. For a slab thickness of  $< 215$  mm:  $\pm 6$  mm
  - ii. For a slab thickness from 215 to 229 mm:  $+15$  /-12 mm
  - iii. For a slab thickness of 230 mm or greater:  $+25$  /-15 mm

The tie bars shall be installed within a tolerance of  $\pm 15$  mm from mid-depth of the slab thickness.

Dowel bars and tie bars shall be installed and secured in a manner that will ensure they remain in the proper position and orientation during the concreting operation.

The epoxy adhesive shall be fully cured prior to placing concrete. The free end of the dowel bars shall be coated with bond breaker immediately prior to placing concrete.

#### **366.07.05.01.03            Transverse Joints**

Transverse contraction joints shall be cut or formed as specified in the Contract Documents and skewed if required. Joints shall have a minimum spacing of 2 m and a maximum spacing of 4 m.

Expansion joints shall be placed where specified in the Contract Documents and when replacing existing expansion joints.

#### **366.07.05.01.04            Mid-Lane Longitudinal Joints for Fast-track Repairs**

In repair areas where the transverse joint spacing is 3 m or less in length, a longitudinal joint shall be created in the middle of the lane and for the full length of the repair. Tie bars shall be placed at mid-depth of the slab along the full length of the longitudinal joint. The tie bars shall be 25M deformed bars and shall be 760 mm in length. These bars shall be spaced every 400 mm and shall not be placed within 400 mm of a transverse joint.

Tie bars shall be installed and secured so that they remain in the proper position and orientation during the concreting operation.

#### **366.07.05.01.05            Sawcutting**

Sawcutting of joints shall be carried out before uncontrolled cracking occurs and prior to opening to traffic. Sawcutting operations shall not result in ravelling or other damage to the concrete. The cut shall extend one-third the depth of the concrete slab.

For fast-track repairs, equipment specifically designed for dry-cut joint sawing shall be used and the sawing shall be carried out within 2 hours of final finishing. In lieu of sawcutting, the joint may be formed to a minimum depth of one third the pavement thickness when the concrete is in the plastic state.

#### **366.07.06                    Production of Concrete**

Production of concrete shall be according to the General, Temperature Control, Mixing Time and Mixing Rate, and Delivery subsections in OPSS 1350.

### **366.07.07                    Placing of Concrete**

Prior to placing concrete, the Contract Administrator may request a demonstration that the equipment to be used provides for proper adjustment of screeds, floats, propulsion, and control equipment to achieve the required end product.

Delivery of concrete shall be according to OPSS 1350.

Placing of concrete in the repair areas shall be according to the Construction section of OPSS 350 with the following exceptions and additions:

- a) Concrete shall be placed in such a way as to avoid disturbing or displacing tie bars, dowel bars or load transfer devices.
- b) When there is an interruption in placing concrete greater than 20 minutes, the surface of the concrete shall be covered with wet burlap.
- c) When an interruption of more than 45 minutes occurs during placing of full depth concrete or 5 minutes for fast-track concrete, a transverse construction joint shall be formed. Notwithstanding the time limits, there shall be no delays which will result in a cold joint. Concrete placed in the areas between the newly formed joint and the previous joint is subject to removal and replacement at no additional cost to the Owner if the Contract Administrator deems it necessary.
- d) The use of insulation to retain heat is permitted.

### **366.07.08                    Consolidating**

Consolidation of concrete in the repair areas shall be according to OPSS 350.

### **366.07.09                    Concrete Finishing**

No water or other chemical agents shall be applied to the concrete surface to aid in the finishing.

For concrete pavements where fixed forms are being used or where concrete is being placed against an existing pavement the edge of the pavement shall be finished, before texturing of the pavement surface, with an edging tool having a radius of not more than 6 mm. The finished pavement edge shall be left smooth, true to line and grade.

### **366.07.10                    Texturing of Pavement Surface**

Texturing of pavement surface shall be according to OPSS 350, except that manual devices may be used to provide the required tined texture.

Texturing is not required on concrete base or when diamond grinding of the pavement surface is specified in the Contract Documents.

### **366.07.11                    Surface Tolerance**

The surface of the concrete repair shall join flush with the existing concrete pavement or concrete base.

The surface of the concrete shall be such that when tested with a 3 m long straightedge placed in any location and direction, including the edge of pavement and joints, except across the crown or drainage gutters, there

shall not be a gap greater than 3 mm between the bottom of the straightedge and the surface of the concrete pavement. For concrete base, the tolerance over a 3 m straightedge shall be 6 mm.

Use of diamond grinding to meet the above requirements shall require the prior approval of the Contract Administrator.

### **366.07.12 Curing**

Curing shall be applied within 10 minutes of placing concrete and immediately following texturing.

The curing period shall be a minimum of 7 Days for concrete cured with curing compound and for concrete subject to cold weather. For all other types of curing, the curing period shall be a minimum of 4 Days.

For fast-track repairs, only curing compound shall be used for curing and may remain in place following the 7 Day curing requirement.

For non-fast-track repairs, concrete shall be cured using one of the following methods, according to the applicable clauses in OPSS 904:

- a) Curing with Curing Compound, or
- b) Curing with Burlap and Water, except during cold weather, when curing shall be according to Curing with Moisture Vapour Barrier.

When curing compound is used, it shall not be applied to joint faces against which sealant is to be placed or to concrete surfaces to which concrete or mortar is to be bonded.

If curing compound is used on repairs to concrete base in areas greater than 10 m in length, the curing compound shall be completely removed from the concrete surface prior to the application of tack coat and the overlaying with asphalt pavement. The method of removal shall be by shot blasting and it shall not result in any damage to the concrete surface.

### **366.07.13 Retaining Heat for Fast-Track Repairs**

Insulating blankets or protection systems of any type may be used for retaining heat to accelerate the strength gain of fast-track repairs. Insulating blankets used for the purpose of accelerating strength gain for fast-track repairs are not required to meet the requirements for cold weather protection of other types of concrete.

### **366.07.14 Cold Weather Protection – Full Depth and Partial Depth Repairs**

#### **366.07.14.01 General**

Except for fast-track repairs, the temperature of the concrete during cold weather shall be monitored and controlled for a period of 7 Days to ensure that the concrete temperature does not fall below 15°C for the first three days of curing and 10°C for the subsequent four days.

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. Conditions shall be monitored and the protection system modified as required. For cold weather conditions, the minimum cold weather protective measures as specified in the Minimum Cold Weather Protective Measures table in OPSS 904 shall be provided.

#### **366.07.14.02 Monitoring and Control of Temperature**

During cold weather, monitoring and control of the concrete and ambient air temperature shall be recorded and submitted to the Contract Administrator. The monitoring shall commence when the concrete is placed.

For each Day's placement of concrete, thermocouple wires shall be embedded within 5 mm of the concrete surface in a minimum of four locations distributed throughout the repair areas, as directed by the Contract Administrator. At least one additional thermocouple shall be installed to measure ambient air temperature above the surface of the concrete and outside of the specified cold weather protection.

The recording of concrete temperatures shall begin at the start of concrete placement. The temperature shall be recorded automatically at intervals no greater than 15 minutes. The thermocouples and instrumentation shall be left in place and temperatures recorded until the end of the monitoring period.

Concrete and ambient air temperature readings shall be monitored and verified on site every 6 hours or more frequently as required for the first 3 Days, and every 12 hours or more frequently as required for the remainder of the monitoring period. Temperature verification shall be carried out in person at each concrete repair location. All necessary action shall be taken to maintain the temperature within the specified limits.

A record of temperatures for each Day during the temperature monitoring period shall be prepared. At the end of the temperature monitoring period, a complete temperature record including graphical plot of temperature versus time shall be prepared.

#### **366.07.14.03 Submission of Temperature Records**

Datalogger temperature records and a record of any actions taken to maintain control of temperature 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, the complete temperature record shall be submitted to the Contract Administrator.

#### **366.07.15 Joint Sealing**

Joint sealing shall be according to OPSS 369.

#### **366.07.16 Material Sampling and Testing**

##### **366.07.16.01 Slump, Air Content and Temperature**

Plastic concrete sampling, testing, acceptance and field adjustments, visual acceptance, and submission of plastic concrete test results shall be according to the "Material Sampling and Testing" subsection of OPSS 1350, with the following exceptions and additions:

- a) Testing of plastic air content is not required for fast-track repairs.
- b) The minimum frequency of testing slump and concrete temperature shall be once for each load of concrete.
- c) For fast-track concrete, if the slump exceeds the maximum allowable slump of 230 mm, the load of concrete shall be rejected. Re-testing of slump of fast-track concrete is not permitted.

##### **366.07.16.02 Coring for Compressive Strength and Air Void System Parameter Testing**

For all concrete pavement repairs including fast-track, cores shall be removed from the hardened concrete for acceptance testing by the Owner. Coring shall be carried out when the concrete is 28 to 35 Days old.

Concrete shall be sampled on a lot basis according to the Quality Assurance section of this specification. For each lot, a total of 5 cores shall be obtained. Cores shall be taken at random locations specified by the Contract Administrator. Four cores shall be taken from one repair area in the lot within 1 m of one another; three for compressive strength testing, and one for air void system (AVS) testing. A single core shall be taken from another repair area within the lot for AVS testing. Cores shall be 100 mm diameter and full depth.

Coring shall be carried out according to CSA A23.2-14C. Cores shall not contain steel reinforcement or other embedded material. A covermeter shall be used to establish the location of reinforcement and other embedded material prior to coring. No core shall be taken within 500 mm of any joint or repair area edge.

The Contract number, lot number, and repair area identification information shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag, sealed to prevent loss of moisture.

Core holes shall be filled according to OPSS 1350.

### **366.07.16.03 Early Strength Determination for Repairs Other than Fast-Track**

For repairs other than fast-track, the Contractor may elect to take cores for early strength determination in addition to the cores required for determination of 28-Day compressive strength. In order to demonstrate that the pavement has achieved sufficient strength for loading of construction vehicles or traffic, one set of three cores shall be taken for each Day's placement, from the last repair placed during that day. Cores shall be 100 mm diameter and full depth. All cores of the same set shall be removed at a location no more than 1 m from the location of the first core for that set.

When the Contractor elects to take cores for early strength determination, core removal and handling shall be carried out according to the Coring for Compressive Strength and Air Void System Parameters clause.

The Contract Administrator shall be provided with 1 Business Day advance notice to arrange testing by the designated quality assurance laboratory.

Core holes shall be filled according to OPSS 1350.

### **366.07.17 Special Requirements of Fast-track Repairs**

#### **366.07.17.01 Trial Area for Fast-track Repairs**

A typical fast-track full depth repair shall be demonstrated at the trial repair area specified in the Contract Documents a minimum of one week prior to any concreting operation. If a trial repair area is not specified in the Contract Documents, a location acceptable to the Contract Administrator shall be selected to demonstrate a repair. The selected repair area shall be a minimum of 2 m long by 3.75 m wide and 0.250 m deep.

The ability to fully complete the trial repair area within the time frame of the lane closure as specified in the Contract Documents shall be demonstrated. The trial repair shall simulate the Contract site conditions as if it were the last repair of the closure and shall include sampling and testing as specified in the Material Sampling and Testing subsection. The trial repair area shall not be overlaid and shall remain exposed for at least seven Days to permit inspection for deficiencies.

The Contractor shall verify the calibration chart for the mix design strength versus temperature and the calibration chart for the mix design temperature versus time using the autogenous cylinder method.

Five cores shall be obtained from the trial repair area according to the Coring for Compressive Strength and Air Void System Parameters clause. Three cores shall be tested for compressive strength and two cores shall

be tested for AVS according to the Quality Assurance section. The compressive strength and air void system shall meet the requirements of this specification.

Permission to proceed with repairs shall only be given when the Contract Administrator is satisfied that all of the above conditions have been met.

A trial repair area is not required if the Contractor has demonstrated successful placement of fast-track repairs, meeting all specification requirements, within the last five years on another ministry Contract.

#### **366.07.17.02 Early Strength Determination for Fast-Track Repairs**

The autogenous cylinder method shall be used to determine compressive strength for purposes of opening the lane to traffic. The Contractor is responsible for the timing and frequency of testing of the autogenous cylinders and shall determine when the concrete pavement or concrete base has attained a minimum compressive strength of 20 MPa.

The Contractor shall make a minimum of three sets of two autogenous test cylinders for the final repair area of each lane closure according to CSA A23.2-3C. The cylinders shall be 150 mm in diameter and 300 mm long.

Compressive strength testing of autogenous cylinders shall be carried out according to CSA A23.2-9C by the Contractor to verify that the concrete in the repair area has attained a minimum compressive strength of 20 MPa. The testing shall be performed at a laboratory certified as a concrete testing laboratory by the Canadian Council of Independent Laboratories (CCIL) that has successfully participated in the MTO correlation program.

The concrete compressive strength specimen shall be tested to complete failure. These test results shall be communicated immediately to the Contract Administrator, prior to re-opening the lane to traffic.

The compressive strength of the concrete in the repair area shall be based on the following procedure:

- a) Install thermocouple wires according to the Monitoring and Control of Temperature for Fast Track Repairs clause.
- b) Monitor and record the temperature of the repair slab and autogenous cylinders a minimum of once every 15 minutes.
- c) Autogenous test cylinders shall be tested in pairs for compressive strength at time intervals determined by the Contractor, until a compressive strength of 20 MPa or greater is obtained. The repaired slab shall not be opened to traffic until the slab temperature has reached at least the same temperature as the cylinders which attained a compressive strength of 20 MPa or greater.

The Contract Administrator shall be provided access to verify temperature readings. If the datalogger does not have a digital display for verifying the temperature, the Contract Administrator shall be provided with the necessary instruments to verify thermocouple function and readings.

A record of the temperatures of the repair slab and autogenous cylinders, and the compressive strength test results shall be submitted to the Contract Administrator for each lane closure.

#### **366.07.17.03 Monitoring and Control of Temperature for Fast Track Repairs**

Thermocouple wires shall be installed at a minimum of two test locations in the final full depth repair area for each lane closure. The thermocouple wires shall be embedded within 5 mm of the concrete surface and at the edge of the repair area.

Thermocouple wires shall also be embedded in each of the autogenous cylinders.



### **366.07.18 Unacceptable Repair Areas**

Concrete found to be unacceptable shall be removed and replaced with new concrete meeting the Contract requirements.

The area to be removed shall extend to the nearest contraction joint and longitudinal joint or edge outside the deficient area so that there are no additional joints.

Concrete which does not meet the surface tolerance may be corrected by diamond grinding in lieu of removal and replacement, subject to approval by the Owner.

### **366.07.19 Management of Excess Material**

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

## **366.08 QUALITY ASSURANCE**

### **366.08.01 Lot Size for 28-Day Compressive Strength and Air Void System Testing**

Concrete shall be accepted on a lot basis. A lot shall consist of up to 400 m<sup>2</sup> of each type of repair. Partial depth and full depth repairs shall be separate lots. Conventional concrete repairs and fast-track concrete repairs shall be separate lots.

For each lot, one set of three cores shall be tested for 28-Day compressive strength and two cores shall be tested for AVS.

### **366.08.02 Acceptance of 28-Day Compressive Strength**

One set of three core samples per lot shall be tested to determine the acceptability of compressive strength of the lot. Compressive strength shall be determined according to LS-410 on moisture conditioned cores. The compressive strength result of a lot shall be the average of the set of the three acceptance cores, rounded to one decimal place.

Compressive strength of a lot shall be considered acceptable when:

- a) The average compressive strength of the set of three cores is equal to or greater than 30 MPa, and
- b) No individual core result is more than 10% below the specified strength.

Unacceptable lots shall be rejected. Concrete from unacceptable lots shall be removed and replaced.

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

### **366.08.02.01 Referee Testing of Compressive Strength**

Referee testing for compressive strength shall be according to OPSS 1350, except that referee testing shall be done on a new set of cores. A set of referee cores for compressive strength shall consist of three individual cores and shall be taken from the same repair area from which acceptance samples were obtained. The new set of cores shall be obtained within 5 Business Days of invoking referee testing.

All cores of the same set shall be removed at a location no more than 1m from the location of the first core for that set.

Coring shall be carried out according to CSA A23.2-14C. No core shall be taken within 500 mm of any joint or repair area edge. The Contractor shall use a covermeter to establish the location of reinforcement and other embedded material prior to coring. Cores shall not contain steel reinforcement or other embedded material.

The Contract number, lot number and repair area identification information shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag, sealed to prevent loss of moisture.

The Contractor shall fill the core holes according to OPSS 1350.

#### **366.08.02.01.01 Referee Testing Cost**

The cost of referee testing of compressive strength shall be as specified in the Contract Documents.

When the referee results indicate that the refereed lot is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed lot is not acceptable, the Contractor shall be charged the cost of the air void system referee testing.

#### **366.08.03 Acceptance of Air Void System in Hardened Concrete**

One half of each core shall be tested according to LS-432 to determine the acceptability of concrete AVS of the lot. The other half of each core shall be retained by the Owner for audit purposes.

For a lot to be considered acceptable, each core shall have air content of 3.0% or more and spacing factor of 0.230 mm or less.

Unacceptable lots shall be rejected. Concrete from unacceptable lots shall be removed and replaced.

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

#### **366.08.03.01 Referee Testing of Air Void System in Hardened Concrete**

Referee testing of AVS parameters may only be invoked by the Contractor within 5 Business Days of receiving the test result.

When referee testing is invoked, both core samples representing a lot shall be referee tested and the acceptance test results discarded. The lot referee test results shall replace the acceptance test result in the acceptance requirements of this specification.

Referee testing shall be carried out on the same half of the core sample that was tested for acceptance.

Cores shall be tested according to LS-431. Referee test results shall be forwarded to the Contractor as they become available.

#### **366.08.03.01.01 Referee Testing Cost**

The cost of AVS referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed lot is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed lot is not acceptable, the Contractor shall be charged the cost of the air void system referee testing.

#### **366.08.04 Falling Weight Deflectometer Acceptance Testing**

The Contractor shall make the work available for testing by the Owner. The Contract Administrator shall carry out falling weight deflectometer (FWD) testing on the approach and leave joints of each full depth conventional and fast-track repair area to determine the load transfer efficiency across the transverse joints. FWD testing, equipment calibration and reporting shall be according LS-447. Each repair shall be acceptable if the FWD test results indicate a load transfer efficiency of 70% or greater. Repair areas with a load transfer efficiency less than 70% shall be removed and replaced.

##### **366.08.04.01 Falling Weight Deflectometer Referee Testing**

FWD referee testing may only be invoked by the Contractor within 5 Business Days of receiving the test result. Referee testing shall be according to LS-447. The referee test result shall replace the acceptance test result in the acceptance requirements of this specification. Referee test results shall be forwarded to the Contractor, as they become available.

##### **366.08.04.01.01 Referee Testing Cost**

When the referee results indicate that the refereed repair is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed repair is not acceptable, the Contractor shall be charged the cost of the FWD referee testing.

#### **366.08.05 Acceptance of Surface Tolerance**

Each repair area shall meet the requirements of the Surface Tolerance section of this specification. Repair areas that do not meet the surface tolerance requirements of this specification shall be considered unacceptable and shall be removed and replaced.

#### **366.08.06 Defects**

Concrete repair areas are unacceptable if they contain any of the following defects:

- a) Concrete with any visible surface cracks in the repair, unless the Contractor demonstrates, at his expense, that the depth of the crack is less than 10 mm.
- b) Concrete with honeycombing or other deficiencies detected visually.
- c) Partial depth repairs with debonding identified by sounding.

Unacceptable concrete shall be removed and replaced.

#### **366.08.07 Acceptance or Rejection**

The lot shall be rejected if any of the following apply:

- a) Compressive strength not meeting the minimum strength requirements prior to opening to traffic.
- b) Average 28-Day compressive strength less than 30 MPa or individual results less than 10% of specified compressive strength.
- c) Air void system not meeting the requirements of this specification.
- d) FWD test results indicating a load transfer efficiency of less than 70%.

- e) Defects listed in the Defects section of this specification are present in the work.
- f) Any work that does not conform to the requirements of this specification.

**366.09 MEASUREMENT FOR PAYMENT**

**366.09.01 Actual Measurement**

**366.09.01.01 Fast-track Concrete Repair  
Full Depth Concrete Repair  
Partial Depth Concrete Repair**

Measurement of fast-track concrete repair, full depth concrete repair, and partial depth concrete repair shall be by the area of the repair in square metres. Each repair area shall be measured to the nearest 0.1 m<sup>2</sup>.

**366.09.02 Plan Quantity Measurement**

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

**366.10 BASIS OF PAYMENT**

**366.10.01 Fast-track Concrete Repair - Item  
Full Depth Concrete Repair - Item  
Partial Depth Concrete Repair - 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.

Concrete and concrete repair areas that are unacceptable shall be removed and replaced at no additional cost to the Owner.

**TABLE 1**  
**Nominal Maximum Size of Coarse Aggregate**

<b>Repair Type</b>	<b>Nominal Maximum Size of Coarse Aggregate</b>
Partial Depth	19.0 mm
Full Depth and Fast-Track	19.0 mm, 37.5 mm or combined gradation of nominal maximum aggregate size of 37.5 and 19.0 mm

