

1. **GENERAL**

1.1 DESCRIPTION

Portland Cement Concrete Pavement (PCCP) shall consist of a mixture of Portland Cement, fine aggregate, coarse aggregate, water, admixtures and supplementary cementing materials (where required) combined in proportions to meet the Specifications herein. PCCP shall be placed and consolidated on a prepared surface, and fitted with load transfer devices and tie bars, with joint formation and sealing, in conformity to the lines, grades, dimensions, and cross-sections as shown on the Drawings or as directed by the Engineer.

1.2 RELATED WORK

- .1 Section 31 23 13 – Subgrade Construction.
- .2 Section 31 24 13 – Roadway Excavation, Embankment and Compaction.
- .3 Section 32 11 23 – Granular Base.

1.3 REFERENCE STANDARDS

- .1 Do Portland Cement Concrete Pavement (PCCP) work in accordance with the latest edition of CAN/CSA-A23.1 and testing in accordance with the latest edition of CAN/CSA-A23.2, except where specified otherwise.

1.4 DEFINITIONS

For the purposes of this Specification, the following definitions shall apply:

- .1 Acceptance Limits
 - .1 Slab Thickness and Compressive Strength - Acceptance Limits for Slab Thickness and Compressive Strength are limiting values of the Lot Mean or individual tests within which the PCCP Lot will be accepted at full, increased, or reduced payment, as determined in Section 7.
 - .2 Smoothness - Acceptance Limit for Smoothness is the limiting value of the Surface Tolerance within which the PCCP Sublot will be accepted at full, increased or reduced payment, as determined by Section 7.
 - .3 Early Compressive Strength - Acceptance Limits for determining PCCP adequacy for early opening of the PCCP section to traffic as specified in Section 5.8.
- .2 End Product Specification (EPS)
 - .1 A specification whereby the Owner does not define the methods of construction. Under EPS, the Engineer will monitor the Contractor's control of the process that produces the items of construction and will accept or reject the end product according to a specified acceptance plan. The Contractor is entirely responsible for quality control. End product acceptance is the responsibility of the Engineer and includes a statistically oriented program of acceptance testing.
- .3 Mix Design
 - .1 The Mix Design establishes the proportioning of Portland Cement, fine aggregate, coarse aggregate, water, admixtures and supplementary cementing materials to be

used for production of Portland cement concrete and requires the written approval of the Engineer prior to production of any Portland Cement concrete under this Contract.

.4 Portland Cement Concrete Pavement (PCCP)

- .1 Portland Cement Concrete Pavement (PCCP) is a rigid pavement structure with an exposed concrete surface which may include concrete shoulders.

.5 PCCP Lot

- .1 A PCCP Lot is a portion of the Work being considered for acceptance and is defined as follows:
- .1 the greater of 300m² or the surface area placed in one day, provided an approved change has not occurred to the mix design. Approved changes to the mix design may require the designation of a new PCCP Lot.
 - .2 One day's production of less than 300m² added to the previous or next days day's Lot at the Engineer's option.
 - .3 If the Engineer suspects a portion of a PCCP Lot is substandard, the Engineer may order extra testing to define the area and severity of the deficiency. A new Lot will be designated for this portion if this extra testing indicates the PCCP is subject to unit price adjustment or rejection.
 - .4 For PCCP placed by hand or placed off the main alignment the Engineer will define the Lot size and limits.

.6 PCCP Sublot

- .1 A PCCP Sublot is a portion of a PCCP Lot that is one lane (3.9m) wide and a maximum of 50m long on which the calculation for smoothness is based.

.7 Lot Mean

- .1 The Lot Mean is the arithmetic mean of all test results constituting the samples for the Lot.

.8 Stratified Random Sample

- .1 A Stratified Random Sample is a set of test measurements taken one each from five (5) or more separate (stratified) areas or segments within a Lot in an unbiased way.

.9 Working Depth Cracks

- .1 Working depth cracks are full depth cracks that are subject to horizontal and/or vertical movement.

2. MATERIALS

2.1 Aggregates

- .1 The Contractor shall supply all aggregates. Testing to verify compliance with the requirements of the latest edition of CAN/CSA A23.1 Clauses 4.2.3.3, 4.2.3.4, 4.2.3.5.1, 4.2.3.6, and 4.2.3.7 and Tables 10 to 12 shall be done at least one (1) time per year on existing stockpiled aggregate to be used on this project and each new aggregate manufactured for use on this project.

2.2 Air-Entrained Mixtures

- .1 The Contractor shall supply and use Air-Entraining admixtures in accordance with the requirements of the latest edition of ASTM C260/C260M-10a.

2.3 Burlap

- .1 The Contractor shall supply burlap that conforms to the requirements of the latest edition of AASHTO M182-05 Class 4 and shall be free from substances that are deleterious to concrete.

2.4 Curing Compound

- .1 The Contractor shall supply curing compound that conforms to the requirements of the latest edition of CAN/CSA-A23.1 and ASTM C309-19, except that the application of Type I curing compounds will not be permitted. The Contractor shall not add any material to the curing compound as delivered by the manufacturer.

2.5 Joint Materials

.1 Expansion Joint Filler

- .1 The Contractor shall supply preformed expansion joint filler in accordance with the following:

Type	Description	Physical Requirement
A	Non-Extruding and Resilient <i>Bituminous</i>	ASTM D1751-04 (2008)
B	Non-Extruding and Resilient <i>Non-Bituminous</i>	ASTM D1752-04a (2008)

.2 Joint Sealant

.1 Backer Rod

- .1 The Contractor shall supply backer rods compatible with the liquid sealant. The backer rods shall be made of polyethylene foam, cross-linked polyethylene foam or polyurethane and shall conform to the requirements of the latest edition of ASTM D5249-10

.2 Liquid Sealant

- .1 The Contractor shall supply liquid sealant that conforms to the requirements of the latest edition of ASTM D6690-15 (Types I and II), ASTM D3406-95 (2006) or ASTM D5893-04.

.3 Compression Seal

- .1 The Contractor shall supply preformed compression seals. Preformed compression seals shall conform to the requirements of the latest edition of ASTM D2628-91 (2016).

2.6 Moisture Vapour Barrier for Curing

- .1 The Contractor shall supply moisture vapour barrier that is white opaque polyethylene film and that conforms to the requirements of the latest edition of ASTM C171-16.

2.7 Portland Cement

- .1 The Contractor shall supply Portland cement in accordance with specific requirements in the latest edition of CAN/CSA-A23.1, as further outlined in this specification. The specific test procedures contained in CAN/CSA-A23.2 that are to be used are further outlined in this specification.

2.8 Supplementary Cementing Materials

- .1 Supplementary cementing materials, including silica fume and Fly Ash shall meet the requirements of the latest edition of CAN/CSA-A3000-18.

2.9 Tie Bars and Dowels

.1 Tie Bars:

- .1 The Contractor shall supply tie bars to the dimensions as indicated on the Drawings. Tie bars shall be 15M, epoxy coated, deformed reinforcing bars that conform to the requirements of the latest edition of ASTM A775/ASTM A775M-17.

.2 Dowels:

- .1 The Contractor shall supply dowels to the dimensions as indicated on the Drawings. Dowel bars shall be plain round bars of grade 300 or better conforming to the requirements of the latest edition of CAN/CSA-G40.21-13 and shall be epoxy coated to the requirements of the latest edition of ASTM A775/ASTM A775M-19. For at least half their length, the dowels shall be coated with oil, grease or other suitable form release agent. The coating shall be applied at the same end of all dowels with reference to the direction of concrete placement.

2.10 Water

- .1 The Contractor shall supply all water required for mixing and curing in accordance with the requirements of CAN/CSA 4.2.2.

3. PORTLAND CEMENT CONCRETE MIX DESIGN

3.1 Responsibility for Mix Design

- .1 Preparation and submission of PCCP mix designs for Engineer verification and approval are the responsibility of the Contractor. The sampling and testing of aggregates and the concrete mix design shall be completed by an independent Category 1 CSA-certified concrete testing laboratory which shall be registered with either APEGS or APEGA depending on the location of the work. The testing laboratory shall provide an engineering opinion that the concrete aggregate and mix designs are suitable for the intended use and are expected to perform to specified standards.
- .2 All costs incurred in mix design formulation are the responsibility of the Contractor. Shipping costs for samples sent to the Engineer for verification and approval are the responsibility of the Contractor.

3.2 Requirements for Mix Design

The mix design shall meet the following requirements:

- .1 The concrete shall have a minimum flexural strength of 4.2MPa at 28 days and a minimum flexural strength 3.2MPa and a maximum flexural strength of 4.5MPa at 7 days.
- .2 The minimum compressive strength at 28 days shall be the greater of 32MPa or the compressive strength required to provide a minimum flexural strength at 28 days of 4.2MPa.
- .3 The nominal maximum size of coarse aggregate shall be either 20-5 mm or 28-5 mm.
- .4 Aggregate for concrete shall conform to the limits and requirements of Table 12 of CAN/CSA-A23.1-19.

- .5 The concrete mix shall be proportioned in accordance with CAN/CSA/A23.2:19 to avoid deleterious expansion due to alkali-aggregate reactivity in a service life of thirty (30) years.
- .6 The slump of the concrete shall be 30mm ±10mm if the concrete is slip formed and 70mm ±20mm if hand placed.
- .7 The entrained air content of the concrete shall be 5.0% to 8.0%.
- .8 The air-void spacing factor shall be determined in accordance with ASTM C457/C457M-16, modified point-count method at 100X times magnification. The average of all tests shall not exceed 230µm with no single test greater than 260µm.
- .9 The maximum water/cementing materials ratio shall be 0.45.
- .10 The minimum cementing materials content shall be 335kg/m³. The minimum cement content shall be 300kg/ m³.
- .11 Supplementary cementing materials shall be restricted to the following proportions by mass of total cementing materials:
 - .1 silica fume up to 8%
 - .2 fly ash up to 25%
- .12 Determination of organic impurities in the fine aggregate shall be completed in accordance with the latest edition of CAN/CSA A23.2:19 and ASTM D 1544-04(2018).
- .13 Class of Exposure: C-2

3.3 Approval of Mix Design

- .1 The Contractor shall determine the 28 day compressive strength that provides a minimum flexural strength of 4.2 MPa at 28 days. The 28 day compressive strength and the 28 day flexural strength shall be determined in accordance with the requirements of the latest edition of CAN/CSA A23.1 and CAN/CSA A23.2.
- .2 Mix designs shall be subject to the approval of the Engineer. The Contractor shall submit the mix design to the Engineer for verification and approval a minimum of four (4) weeks prior to commencement of the Contract. The Contractor's submission shall include the following information:
 - .1 The flexural strength at 28 days (MPa).
 - .2 The compressive strength at 28 days (MPa).
 - .3 The nominal maximum size of coarse aggregate (mm).
 - .4 The coarse aggregate content (kg/m³).
 - .5 The fine aggregate content (kg/m³).
 - .6 The source(s) and location(s) of the coarse and fine aggregates.
 - .7 The gradation of the coarse and fine aggregates to be used in the mix.
 - .8 Test results indicating compliance with the latest edition of CAN/CSA-A23.1:19 (Organic Impurities in Sand for Concrete - Color Plate).
 - .9 Test results indicating compliance with Section 3.2.4.
 - .10 The results from the alkali aggregate reactivity tests.
 - .11 The target slump of the concrete (mm).
 - .12 The entrained air content of the concrete (% by volume).
 - .13 The water/cementing materials ratio (% by mass).
 - .14 The cementing materials content (kg/m³) and proportions (% by mass).
 - .15 Linear Traverse test results indicating compliance with Section 3.2.8.

- .16 All data on proposed concrete admixtures and/or fibers.
- .17 The results of trial batch testing for the concrete mix for compliance with specified concrete properties. Any changes in the materials and/or quantities shall require a new trial batch testing.

OR

- .2 In the case of proprietary mix designs, the sampling and testing of aggregates and the concrete mix design shall be completed by an independent CSA certified and qualified concrete testing laboratory which shall be registered with either AEPEGS or APEGA depending on the location of the work. Concrete mix designs including sampling and testing of aggregates may be completed by the concrete supplier with the condition that the documentation is stamped by a Professional Engineer registered and licensed to practice in the Province of Alberta or Saskatchewan. For these situations, the mix design shall be reviewed and stamped for compliance with respective specifications by an independent CSA certified and qualified concrete testing laboratory. For either case, the testing laboratory shall provide an engineering opinion that concrete aggregate and mix designs are suitable for the intended use and are expected to perform to the specified standards.
- .3 The Contractor shall submit the proposed mix design for the concrete for the Engineer's review at least two weeks before scheduled placing of concrete. Sampling and testing of aggregates shall fully represent the material to be used in the production of concrete for PCCP. Sampling and testing shall have been conducted not more than 180 days prior to the start of production of concrete for PCCP.
- .4 Where required by the Engineer for any change in the nature or sources of the aggregates, or where a new mix design is desired by the Contractor, the Contractor shall provide a separate and complete mix design. This new mix design shall be subject to the approval of the Engineer.
- .5 PCCP mix produced and placed prior to the Contractor receiving the Engineer's written approval of the mix design will not be accepted and will be subject to removal and replacement with approved-mix PCCP concrete at the Contractor's expense.

The Contractor is responsible for producing mixes that conform to the Specifications.

4. SAMPLING AND TESTING

4.1 General

- .1 During the progress of the work, testing is to be carried out on materials and workmanship in order to ensure compliance with the requirements of the Specifications.
- .2 The Engineer's approval of any materials or mixture shall in no way relieve the Contractor from his obligation to provide materials, mixtures and workmanship in accordance with the Specifications.
- .3 Where specified, random sampling procedures shall be followed, and where no specific random sampling procedure is specified, the sampling procedure will be as identified by the Engineer in the case of acceptance testing and by the Contractor in the case of quality control testing.
- .4 The Engineer shall have access to the Work at all times for taking samples. The Contractor shall provide any assistance necessary for taking samples and shall reinstate pavement layers or other structures to the satisfaction of the Engineer at the positions where

samples have been taken. Compensation for providing assistance with sampling and for reinstatement where samples are taken shall be included in the unit price bid for the various items of work tested and no separate payment will be made.

- .5 The Contractor shall provide, at his own expense, sampling devices and other facilities which the Engineer may require to safely obtain representative samples of the item being produced.

4.2 Quality Control Testing

.1 General

- .1 Quality Control Testing is the responsibility of the Contractor throughout every stage of the Work. Tests performed by the Engineer will not be considered to be quality control tests. The Contractor shall provide and pay for CSA certified personnel and equipment to perform all quality control sampling and testing necessary to determine and monitor the characteristics of the materials produced and incorporated into the Work, and the final product.
- .2 All costs associated with PCCP coring for quality control testing shall be the responsibility of the Contractor.
- .3 Test methods and sampling requirements are described in Table 4.2.2, Quality Control Testing Requirements. The frequency of tests shall conform to the requirements of the latest edition of CAN/CSA-A23.1. The Engineer may require an increase in the frequency of any quality control test which has a specified minimum frequency. The Contractor shall pay for any additional tests required by the Engineer.
- .4 Results of all quality control tests shall be submitted to the Engineer, Contractor, and Concrete Supplier (where applicable) within twenty-four (24) hours of their availability.
- .5 The Contractor shall bear the cost of all consulting services retained by him.
- .6 The Contractor shall be totally responsible for production of aggregates and mixes that meet all the specified requirements.

.2 Quality Control Testing Requirements

- .1 Unless otherwise specified, the most recent editions of the following standard test methods shall apply. The Contractor shall conduct the Quality Control Testing in accordance with the following:

Table 4.2.2 Quality Control Testing Requirement

Test	Standard (Latest edition)	Minimum Frequency
Sampling Plastic Concrete	CAN/CSA-A23.2-1C	As required
Sampling - QA cores	CAN/CSA-A23.2-14C	As outlined in Section 4.4
Compressive Strength	CAN/CSA-A23.2-3C & 9C	Not specified
Compressive Strength for Early Opening to Traffic*	CAN/CSA-A23.2-3C & 9C	As outlined in Section 5.8, see Note 1

Compressive Strength for Full and Partial Depth Repairs	CAN/CSA-A23.2-3C & 9C	As outlined in Sections 5.9 & 5.10
Density, Yield, and Cementing Material Factor	CAN/CSA-A23.2-6C	Not specified, other than that required for Uniformity of Mixed Concrete
Slump**	CAN/CSA-A23.2-5C	Note 2
Air Content**	CAN/CSA-A23.2-4C	Note 2
Uniformity of Mixed Concrete	CAN/CSA-A23.1-04	As outlined in 4.2.2.2
Flexural Strength @ 28 days	CAN/CSA-A23.2-3C & 2-8C	Not specified
Linear Traverse	ASTM C457/C457m-16	One for every 300 cubic metres of concrete place

- .1 *Note 1 - Determination of in-situ strength for opening to traffic shall be the responsibility of the Contractor. The Contractor shall be required to submit a proposed in-situ strength testing program to the Engineer for approval at least two (2) weeks prior to commencing production of PCCP.
- .2 **Note 2 - Air Content and Slump shall be checked on the first five (5) loads of the day and every fifth (5th) load thereafter. The results shall be recorded in tabular form and turned over to the Engineer at the conclusion of each day's pour.
 - .1 Failure to meet Slump and/or Air Requirements
 - .1 In the event that actual slump is outside the specified tolerance or the actual air content is higher than the specified tolerance as determined by the Contractor's or the Engineer's testing, the Contractor shall be required to submit adjustments to the mix design or operations to correct the deficient condition, provided the adjustments made prevent future occurrences and are to the satisfaction of the Engineer.
 - .2 In the case of the air content being lower than specified tolerance, the Contractor shall be required to submit the results of testing in which the concrete placed is in compliance with Section 3.2.8 Sampling and testing costs associated with verifying the suitability of suspect concrete shall be the responsibility of the Contractor.
 - .2 Uniformity of Mixed Concrete
 - .1 Testing for equipment or construction process suitability shall be completed by the Contractor, in the presence of the Engineer, on the first day of PCCP placement at a mutually agreed upon time.
 - .2 The concrete will be judged to be uniform or non-uniform based upon the range for each test procedure, compared to the criteria listed in Table 4.2.2.2 as follows:

- a) Where the range, within each test procedure, is equal to or less than the acceptance limit, the concrete shall be considered uniform.
- b) Where the range within any single test procedure is greater than the rejection limit, the concrete shall be considered non-uniform.
- c) Where the range of any single test procedure falls between the acceptance and rejection limits, additional samples shall be taken on the next consecutive batch or load delivered by that unit and tested. If the range within any single test procedure is greater than the acceptance limit, the concrete shall be considered non-uniform.

Table 4.2.2.2 Determination of Within-Batch Uniformity

Test Procedures for Determining Uniformity	Range Between Highest and Lowest Value of Three (3) Test Samples	
	Acceptance	Rejection
Density of Concrete (kg/m ³)	30	50
Air Content, (%)	0.8	1
Slump (mm)	30	50

- .3 If the concrete has been considered non-uniform, the equipment and/or construction process shall be rejected. The equipment shall not be used until it passes a retest, nor shall it be submitted for retesting unless the condition presumed to have caused the lack of uniformity has been corrected.
- .4 The Engineer may order the testing for uniformity of mixed concrete to be repeated at any time there is a change in mix design, equipment or construction process.

4.3 Acceptance Sampling and Testing

.1 General

- .1 Within this Specification, certain requirements, limits, and tolerances are specified regarding the quality of materials and workmanship to be supplied. Compliance with these requirements where so specified will be determined by statistical testing as described in this Specification.
- .2 Acceptance Testing is the responsibility of the Engineer representing the Owner.
- .3 For Acceptance Testing purposes, a Lot is deemed to be completed at the end of the day of placement, after which time the Engineer may commence acceptance testing.
- .4 Initial acceptance testing will be performed free of cost to the Contractor. The Contractor shall be responsible for the cost of all quality assurance testing performed on material that is used to replace material that has been previously rejected.
- .5 The Contractor shall be responsible for the cost of all quality assurance retesting performed following attempts to improve smoothness or to remove bumps and dips.
- .6 After all quality control tests for the PCCP Lot are reported to the Engineer, the Engineer will provide the Contractor with a copy of the results of acceptance tests within 24 hours of their availability.

- .7 If the Engineer determines that certain test results are faulty due to testing equipment malfunction, improper testing procedures or calculations, he will replace the faulty tests with new tests.
- .8 If the testing equipment malfunction, improper testing procedure or calculations were on the part of the Engineer, the Contractor shall be reimbursed \$100 per location for obtaining replacement cores (only when replacement cores are required to complete the test).

4.4 Acceptance Sampling and Testing Procedures

- .1 Coring for Compressive Strength and Thickness
 - .1 Coring will be carried out by the Contractor or his agent (in the presence of the Engineer) when the concrete is at least twenty-eight (28) days old. The cores will be 100 mm in diameter and will be drilled through the complete depth of PCCP perpendicular to the surface of the slab. The Contractor shall fill each core hole immediately after coring with an approved non-shrink grout. The patch shall be finished flush with the surface of the PCCP slab. Immediately before filling, the surfaces of each hole shall be thoroughly cleaned and dried of the paste to ensure a proper bond between the existing concrete and the grout. After filling each hole, all excess material shall be removed from the surface of the PCCP slab.
 - .2 A minimum of five (5) cores shall be taken for each PCCP Lot and turned over to the Engineer for testing. The location of the cores will be selected by the Engineer using a random number generator. No cores will be taken within 250mm of the edge of the slab. Caution will be exercised when coring near longitudinal and transverse joints in order to avoid coring through tie bars, dowel bars and dowel basket assemblies.
 - .3 Coring and filling of the core holes shall be at the Contractor's cost and no additional payment will be made for this Work.
 - .4 Compressive strength will be determined by the Engineer in accordance with the latest edition of CAN/CSA-A23.2-14C (wet curing method). For the purposes of this project, Clause 4.4.2.2.1.4 from CAN/CSA-A23.1 shall not apply. Thickness will be determined in accordance with ASTM C174/C174M-16. The compressive strength and thickness so determined will be the basis for payment to the Contractor in accordance with Section 7.0.
- .2 Pavement Sampling for Smoothness
 - .1 The surface of selected PCCP Sublots will be measured using a 3.0m straightedge to confirm compliance with specified Surface Tolerance. The profiles will be taken at a minimum of five (5) and a maximum of ten (10) random locations per Sublot as selected by the Engineer.

4.5 Retesting Following Attempts to Improve Smoothness

- .1 When the test results on a PCCP Sublot indicate a penalty or rejection because of smoothness, the Contractor, at his option, may make one attempt to improve the smoothness on the Sublot by additional work in which case the following shall apply:
 - .1 the Contractor shall notify the Engineer in writing that he shall make one (1) attempt to improve smoothness.
 - .2 The Contractor shall notify the Engineer, in writing, when the additional work has been completed.
 - .3 Additional work on a PCCP Sublot to improve smoothness shall be completed within seven (7) calendar days from the time the Contractor receives written notification from the Engineer indicating the smoothness test results for that PCCP Sublot.
 - .4 The Contractor shall not undertake any method of repair that is detrimental to the quality of the pavement.

4.6 Appeal of Core Compressive Strength and Thickness Results

- .1 The Contractor may appeal the results of acceptance testing of Core Compressive Strength and Thickness for any rejected or penalized PCCP Lot only once. Appeals will only be considered if cause can be shown. The appeal shall be for all tests within the PCCP Lot, and there will be no appeal allowed for single tests within a PCCP Lot.
- .2 The following procedures will apply for an appeal:
 - .1 The Contractor shall serve notice of appeal to the Engineer, in writing, within twenty-four (24) hours of receipt of the test results.
 - .2 The Engineer will arrange and pay for an independent testing laboratory with CSA certification and registered with either APEGS or APEGA, as may be required, to perform the appeal testing. The personnel employed or testing laboratory retained by the Contractor for quality control testing on the project cannot be used for appeal testing.
 - .3 The Engineer will sample the PCCP and provide the sample(s) to the independent testing laboratory. The Contractor may observe the sampling process. The number and location of the new tests for each segment shall be in accordance with Section 4.3.2.
 - .4 The single low test result from the old PCCP Lot will be rejected and the remaining test results will be added to the results of the new test(s). A new PCCP Lot Mean for the test results will be determined and used for acceptance and unit price adjustment.
- .6 The new values, thus determined, will be binding on the Contractor and the Owner.

4.7 Appeal of Smoothness Results

- .1 The Contractor may appeal acceptance test results of smoothness of any rejected or penalized PCCP Sublot once. The appeal shall be in writing and submitted within twenty-four (24) hours of receipt of the test results.
- .2 Any attempt to improve smoothness on the appealed PCCP Sublot after the Engineer has tested the PCCP Sublot for acceptance shall void the appeal and the original test results will apply.
- .3 The appeal testing will be performed by the Engineer and the new results, thus determined, will be binding on the Contractor and the Owner.

4.8 Payment of Appeal Testing Costs for Core Compressive Strength, Thickness and Smoothness

- .1 If the new results show that a negative unit price adjustment no longer applies, then sampling and testing costs for the appeal procedures for that Lot will be the responsibility of the Owner. Furthermore, in such cases, the Contractor shall be reimbursed sampling costs at the rate of \$100 per core location.
- .2 If the new results verify that any unit price reduction or rejection remains valid for that Lot, then the Contractor shall be invoiced by the Owner for the testing costs for the appeal procedures, at the following rates:
 - .1 Core Compressive Strength:
 - .1 \$1,500 per Lot
 - .2 Thickness:
 - .1 \$500 per test, or \$250 if included in the appeal of core compressive strength
 - .3 Surface Tolerance:
 - .1 \$150.00 per hour (including travel time, testing time and stand-by time)

5. CONSTRUCTION

5.1 Equipment

.1 General

- .1 Equipment shall be designed and operated to produce an end product complying with the requirements of this Specification.

.2 Slipform Paver

- .1 If a slip form paving machine is used for concrete placement, it shall be of a size and type adequate to handle the width and thickness of the concrete pavement to be constructed, adjustable to crown and crossfall. The slip form paver shall distribute the fresh concrete evenly to the required grade without segregation and without disturbing the reinforcing steel. The concrete shall be thoroughly consolidated by means of vibrators, struck off to exact grade, and given a float finish, all automatically and continuously by the machine and with a minimum of hand finishing. The machine shall be equipped with automatic controls capable of controlling both the elevation and direction of the machine within a tolerance of 5 mm from the specified grade and alignment. Slip forms shall extend the full depth of the pavement and shall be of sufficient length that the concrete will not deform at the edges by the time the forms have passed. If a slip form paver is not being used, the paving equipment used for placing concrete shall have a demonstrated ability to meet the specified tolerances for concrete pavement. The Engineer shall reject any paving equipment should the paving equipment not field perform within the specified tolerances.

.3 Automatic Dowel Bar Inserter

- .1 Where an automatic dowel bar inserter is used it shall be capable of placing dowel bars as specified. The dowel bars shall be inserted mid-depth of the slab, centred on the transverse joint locations and spaced as shown on the Drawings. The equipment shall be capable of consolidating the concrete around the dowel bars.

.4 Consolidating

- .1 Concrete shall be consolidated by means of surface vibrators, internal vibrators, or a combination of both that provides full depth consolidation without segregation.

.5 Diamond Grinder

- .1 Where a diamond grinder is used to improve smoothness, it shall be power driven, self-propelled equipment specifically designed to grind and texture concrete pavement. It shall be equipped with a grinding head with at least fifty (50) diamond blades per 300mm of shaft. The grinding head shall be at least 0.9m wide. The grinder shall be equipped with the capability to adjust the depth, slope and cross-slope 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.

.6 Forms

- .1 The Contractor shall supply all formwork in accordance with BCS, Section 4, Cast-In-Place Concrete.

.7 Joint Sealant

- .1 The Contractor shall supply all equipment necessary to install the joint sealant in accordance with the manufacturer's recommendations.

.8 Production and Delivery of Portland Cement Concrete

- .1 The Contractor shall produce and deliver Portland Cement concrete in accordance with the requirements of Section 5, Production and Delivery of the latest edition of CAN/CSA-A23.1, unless otherwise approved by the Engineer.

5.2 Preparation of Existing Surface

- .1 The Contractor shall maintain the finished granular base course in a smooth and compacted condition until the concrete is placed. An asphaltic prime coat shall not be applied to the granular base course surface.
- .2 The granular base course shall be wetted down thoroughly, immediately ahead of the concrete placing operation. The wetting down operation shall be carried out without leaving standing water.
- .3 Concrete shall not be placed on a frozen surface.
- .4 The existing surface shall be inspected by the Engineer prior to placing concrete.

5.3 Protection of Sub-grade

- .1 The mixer, ready-mix trucks, or other equipment shall not operate between the forms in the paving lane unless conditions of the job do not permit operation from the shoulder or outside the lane. If it is necessary to operate trucks between the forms, and the trucks cause rutting or displacement of the sub-grade material, either lighter trucks shall be used or suitable runways shall be provided. The Contractor shall re-roll or hand-tamp the sub-grade to correct any rut or other objectionable irregularities that may have been caused by trucking.

5.4 Joints

.1 General

- .1 Joints shall be of the type and at the location shown on the Drawings. The Contractor shall be responsible for the layout, placement and construction of all joints.
- .2 All joints in pavement slabs shall be continuous through the curbs, median slabs, bull-noses, safety medians and boulevard or median splash strips.
- .3 Expansion joints shall be constructed only where new concrete is being placed up against existing non-pavement structures, where directed by the Engineer. A 15mm thick fibre joint filler shall be installed in expansion joints. The fibre joint filler shall extend from the base of the concrete slab up to the concrete surface, but no higher.
- .4 Where concrete is to be placed against an existing pavement structure, the joint shall be constructed as shown on the Drawings, or as directed by the Engineer.
- .5 The Contractor shall obtain the Engineer's approval on all placement of reinforcing steel in odd shaped installations to ensure proper alignment with saw-cut joints.
- .6 Contraction joints shall be saw-cut in succession by a single cut, 3mm wide to the depths and alignments as shown on the Drawings, as soon as the concrete is sufficiently hard so that it will not be ravelled or damaged by the blade. The time at which all such saw-cutting is to be undertaken shall be determined by the Contractor.
- .7 When construction joints are to be sealed; the joint must be second cut to a width and depth as shown on the drawings.
- .8 Longitudinal joints shall be saw-cut as per contraction joints. When sawing longitudinal joints, the Contractor shall ensure that any residue cleaned from the longitudinal joint does not go into the previously cleaned contraction joints.

.2 Dowel Bars at Transverse Joints

- .1 At all expansion and contraction joints, dowel bars shall be installed in accordance with the details on the Drawings. The location of dowel bars shall be marked to permit precise joint forming or cutting operations directly over the centre of the dowel bars.
- .2 Dowel baskets used in the placement of dowel bars shall be as shown on the Drawings and/or subject to the approval of the Engineer.
- .3 When an automatic dowel bar inserter is used, the Contractor shall be required to either:
 - .1 Remove a two (2) metre by full-paver-width area of PCCP, as determined by the Engineer, that was placed during the first day of paving. The area that is removed will be inspected by the Engineer to ensure that the placement and alignment of the dowel bars meets the requirements of this Specification. If the dowel bars were not placed and aligned as specified, additional areas shall be removed by the Contractor until the Contractor's operations conform to the Specification. The area that has been removed shall be replaced in accordance with Section 5.9. All costs associated with section removal and replacement will be considered incidental to the Work, and no separate or additional payment will be made.

OR

- .2 Demonstrate by other means acceptable to the Engineer that the placement and alignment of the dowel bars meets the requirements of this specification. All costs incurred under this option will be the responsibility of the Contractor.

.3 Tie Bars

- .1 At longitudinal joints, epoxy coated tie bars shall be installed where specified and as detailed on the Drawings. Tie bars shall be inserted so that voids are not created around the bar. Tie bars shall not be placed within 400mm of a transverse joint.

.4 Position and Alignment Tolerances

- .1 Dowel Bars:

The dowel bars shall be placed within a tolerance of ± 6 mm across the length of the bar in the vertical and horizontal planes of the PCCP. In addition, the dowel bars shall be located within ± 12 mm of their proper alignment position.
- .2 Joints:

All joints shall be sawn within a tolerance of ± 15 mm from the position and alignment of the centre of the dowel bars.
- .3 If dowels or tie bars are displaced during concrete placing operations, concrete placement shall cease and shall not resume until the displaced dowels or tie bars have been reset to the true design position.
- .4 Once dowels and tie bars are in position, they shall be inspected and approved by the Engineer before any concrete is placed. Otherwise the concrete will be rejected by the Engineer and shall be removed by the Contractor at his own expense.

.5 Handling and Storing Tie Bars and Dowel Bars

- .1 The Contractor shall handle and store tie bars and dowel bars in accordance with the requirements for reinforcing steel BCS, Section 5, Reinforcing Steel.

.6 Transverse Construction Joints

- .1 Transverse construction joints shall be made at the end of each day's run or when interruptions occur in the concreting operation. Transverse construction joints shall

be formed at a contraction or expansion joint, except in cases of plant breakdown or adverse weather conditions. In these situations, a construction joint may be formed in the mid slab area subject to the provision that the portion of the slab placed, and the portion of the slab to be placed, is not less than two metres long. Construction joints in adjacent lanes shall align with the joints in the previously placed lane.

5.5 Concreting

- .1 General
 - .1 Concrete shall be placed at its permanent location in such a manner so as to avoid segregation of the materials. The Contractor shall repair any segregated concrete in accordance with Section 5.9 or 5.10. Any excess concrete beyond the PCCP edge shall be removed immediately.
 - .2 Transverse joint dowel baskets shall be placed a minimum of 40m in advance of the paving operations where possible.
 - .3 Concrete shall not be placed against any material that is at a temperature above 35°C or below 5°C. In addition, the ambient temperature for concrete placement shall be between 5°C and 32°C unless adequate measures are taken to protect the concrete as outlined further in this Specification.
 - .4 Place concrete continuously until the scheduled pour is complete. Arrange the rate of concrete delivery to ensure that the discharge interval between successive loads does not exceed thirty (30) minutes. If the discharge interval is exceeded, place a construction joint.
 - .5 Portland cement concrete, placed by slip form pavers and related equipment, shall be to the depth, width, crown, and grade shown on the plans.
 - .6 The slip-form paver shall be self-propelled and shall be mounted on two (2) sets of crawler treads each not less than 250mm wide and 6.5m long, except that, where a widening strip is constructed adjacent to a previously constructed pavement the propelling unit may be mounted on rubber-tired wheels and operated on the adjacent pavement. The machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable for loss of crown or other derangement due to wear.
 - .7 Prior to placing concrete, the base surface shall be thoroughly wetted so that it shall not absorb moisture from the concrete to be placed. The method of sprinkling shall be such that no pools of water form on the base. No concrete shall be placed around manholes or other structures until they have been brought up to the required grade or alignment or until expansion joint material is placed around them for the full depth of the pavement.
 - .8 The concrete shall be deposited on the base in a manner requiring a minimum of re-handling. It shall be distributed to sufficient depth above the base that, when consolidated and finished, the slab thickness as shown on the plans shall be obtained at all points and the surface shall not be below the grade specified at any point.
 - .9 No concrete shall be placed until the Engineer has examined and approved the layout of the forms, reinforcing steel, dowels, tie bars and joints and the condition and grade of the compacted base course.
 - .10 The placing of concrete on a base course which is too wet or too dry, or which is frozen, will not be permitted. The prepared grade shall be sufficiently moist to prevent absorption of water from the freshly placed concrete but must be free from mire or water pondage. The temperature of the fresh concrete shall not be less than 10°C nor greater than 30°C, as measured at time of placing.
 - .11 Concrete shall be deposited as nearly as practicable to its final position in a rapid and continuous operation in such a manner as to require as little re-handling as possible and to avoid segregation and separation of the materials.
 - .12 The sequence of concrete placement shall be arranged so that no concrete, which has partially hardened, will be subjected to injurious vibration or shock.

- .13 Concrete shall be placed while fresh and before it has taken its initial set. Re-tempering of partially hardened concrete with additional water will not be permitted.
 - .14 The deposited concrete shall be spread by means of a mechanical spreader or by an approved hand method. The surface of the concrete shall then be struck off by mechanical means in a manner such that when the concrete is vibrated and screeded the finished concrete will conform to the cross-section and elevation shown on the Drawings.
 - .15 In areas inaccessible to mechanical equipment, after the concrete has been vibrated, the surface of the concrete shall be struck-off manually with appropriate tools and in an approved manner so that the concrete will conform to the cross-section and elevation shown on the Drawings. Neat cement or mortar shall not be used to facilitate the finishing surfaces.
 - .16 Mechanical vibrators only shall be used to consolidate the concrete. Spading, hand tamping, using puddling rods, or using other similar methods will not be permitted in place of vibration.
 - .17 Vibration shall be applied at the point of deposit and in areas of freshly deposited concrete. Vibrators shall be inserted vertically into and withdrawn vertically out of the concrete slowly. Vibrations shall be of sufficient duration and intensity to thoroughly consolidate the concrete but shall not be continued so as to cause segregation. Vibrators shall not be used for flowing the concrete or spreading it into place.
 - .18 Concrete shall be worked thoroughly around any reinforcement, dowels, tie bars and around embedded fixtures and into the angles and corners of the forms. During placement, concrete shall be sufficiently vibrated with suitable equipment to ensure a secure bond with the reinforcement, dowels and tie bars, to eliminate entrapped air voids, and to ensure a homogeneous structure and adequate consolidation. Particular care shall be given to placing and vibrating the concrete along the faces of the forms to ensure a dense, smooth surface devoid of imperfections.
 - .19 Once the placing and vibrating of the concrete has been completed, the forms shall not be jarred, and any projecting reinforcing steel shall not be disturbed, for a period of at least twenty-four (24) hours. At the end of a slip form paving pour, concrete shall be sawcut full-depth and removed. There shall be no measurement or pavement for the saw cutting, removal or concrete lost.
- .5 Forms
- .1 Forms shall be of such cross-section and strength and so secured as to resist the pressure of the concrete when placed and the impact and vibration of any equipment which they support, without springing or settlement. The method of connection between sections shall be such that the joints shall not move in any direction.
 - .2 All side forms for this work shall be of metal. These shall be shaped steel sections and shall have a depth of at least equal to the edge thickness of the work prescribed and shall have a base equalling eighty (80) percent of the height of the form with a minimum base width of 150mm. The forms shall be free from warps, bends or kinks. Approved flexible forms shall be used for construction where the radius is 60 m or less.
 - .3 The forms when set are uniformly supported for the entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are staggered and free from play or movement in any direction.
 - .4 After the forms are set they are checked with a three metres straightedge. The maximum deviation from the design elevation and alignment shall be:
 - .1 3mm for the top surface of any form or line of forms.
 - .2 6mm for the inside face of forms.
 - .5 The alignment and grade elevations of the forms shall be checked by the Contractor and the necessary corrections made immediately before placing the concrete. Forms

- remain in place at least 12 hours after the concrete has been placed against them. All forms shall be thoroughly cleaned and oiled each time they are used.
- .6 Forms shall be removed during daylight hours only, and in such a manner as to avoid damage to the pavement.
 - .7 Forms shall be adequately anchored and firmly set over bearing areas to prevent displacement during concrete placement. All formwork in place shall be subject to inspection and correction of grade and alignment prior to, and at any time during concrete placement.
 - .8 The surfaces of all formwork to come in contact with the concrete shall be thoroughly cleaned and treated with form coating before concrete placement. The form coating shall be applied by brush or spray so as to give the forms an even coating without excess or drip and shall not be allowed to get on any reinforcing steel. The form coating shall not cause a softening or permanent staining of the concrete surface and, further, it shall not impede the proper functioning of the curing compound.
- .3 Consolidating
 - .1 Concrete shall be thoroughly consolidated against and along the face of all forms and into the face of previously placed concrete.
 - .2 For fixed-form placement, hand-held vibrators shall be used to supplement consolidation adjacent and along the full length of the form. They shall also be inserted at regularly spaced intervals along both sides of dowel assemblies. Vibrators shall not operate longer than fifteen seconds in any one location.
 - .3 For slip-form pavers the concrete shall be consolidated by vibrators of sufficient number, spacing and frequency to provide uniform consolidation to the entire PCCP width and depth. The vibrators shall not operate while the paver is stopped.
 - .4 The vibrators shall not come in contact with the subgrade, subbase, forms, tie bars or dowel assemblies.
 - .4 Finishing
 - .1 General
 - .1 No water or other chemical agents shall be applied to the surface or the sides of the concrete for finishing purposes.
 - .2 For PCCP where fixed forms are being used or where concrete is being placed against an existing pavement and before surface texturing, the edge of the PCCP shall be finished with an edging tool having a radius of not more than 6mm. The finished PCCP edge shall be left smooth and true to line and grade.
 - .3 If slab edge sags, repair immediately by hand forming; do not use concrete mortar to top off the sag. If edge sagging persists, suspend operations and perform corrective measures.
 - .4 Finishing shall be regulated in order that quality of the surface is not impaired by overworking or by bringing excessive fines and water to the surface. The use of steel trowels is not permitted.
 - .5 Where placement of the concrete pavement is facilitated by use of a slip form paving machine, additional floating of the surface by hand methods shall only be done if required to correct surface imperfections identified by checking with the 3m long metal straight edge, or as directed by the Engineer.
 - .2 Machine Placing and Finishing
 - .1 The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand finishing methods may be used only with the written permission of the Engineer, except in areas where the width of the slab changes.
 - .2 During the operation of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. Except

when making a construction joint, the finishing machine shall not be operated beyond that point where the just-noted ridge, or surplus, of concrete can be maintained ahead of the front screed.

- .3 The concrete, through the use of this machine, shall be left with a true and even surface, free from rock pockets. When properly consolidated and finished the surface of the pavement shall be to the exact grade elevation, crown, and cross-section shown on the plans.
- .3 Texturing of Surface
 - .1 After the concrete has been struck off and consolidated, it shall be further smoothed by means of a mechanical float of a design approved by the Engineer. The machine shall be of such a design that the float is operated transversely across the pavement, with its longitudinal axis approximately parallel to the centre line. Successive passes shall be lapped by at least half the length of the float.
 - .2 After floating, the pavement shall be scraped with a straightedge. The straightedge shall be from two to three metres long and equipped with a handle of sufficient length to permit it to be operated from the edge of the pavement. The straightedge shall be operated so that any excess water, laitance, and inert material are removed from the surface of the pavement.
 - .3 Prolonged operation over any given area shall be avoided.
 - .4 Hand finishing tools shall be kept available for use in the event of a breakdown of the finishing machine.
 - .5 Hand Placing and Finishing
 - .1 When hand finishing is permitted, the concrete shall be struck off and consolidated by a vibrating screed to the exact elevation as shown on the plans. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off.
 - .2 After the concrete has been struck off and consolidated, it shall be further smoothed by the use of a float. The float shall not be less than 3.5m long and 150mm wide and shall be properly stiffened and provide handles at each end.
 - .3 Hand finishing and the use of edging tools are kept to an absolute minimum. No tool marks of any kind should be present in the finished surface.
 - .4 Prolonged operation over any given area shall be avoided.
 - .6 Straight-Edge Finishing
 - .1 After the floating is completed, but while the concrete is still plastic, minor irregularities and score marks remaining in the pavement surface are eliminated by means of long-handled magnesium bow floats and straightedges. When necessary, excess water and laitance are removed from the surface transversely by means of a finishing straightedge. The long-handled floats may be used to smooth and fill in open-textured areas in the pavement surface, but the final finish shall be made with the straightedge.
 - .2 The use of long-handled floats shall be held to the minimum necessary to correct local surface unevenness not taken care of by the float. It shall not be used to float the entire pavement surface.
 - .3 Straightedges shall not be less than 3m in length and shall be operated from bridges and from the side of the pavement. A straightedge operated from the side of the pavement shall be equipped with a handle 1m longer than half the width of the pavement. The surface shall be tested in trueness with a straightedge, which shall be held in successive positions parallel and at right angles to the centre line of the pavement in contact with the surface and the whole area covered as necessary to detect variations.

- .4 The straightedge shall be advanced along the pavement in successive stages not more than half its length. Depressions are immediately filled with freshly mixed concrete, struck-off, consolidated, and refinished. Projections above the required elevations also shall be struck-off and refinished. The straightedge testing and finishing continues until the entire surface is free from observable departure from the straightedge and conforms to the required grade and contour; and when the concrete is hardened, shall conform with the surface requirements specified.

.7 Texturing of Surface

- .1 After all finishing operations are completed on the PCCP and before initial curing and protection of the concrete, the plastic surface of the concrete shall receive an initial and final texturing. Initial texturing shall be performed with a longitudinal burlap drag to produce a uniform textured surface. Burlap shall be kept in a clean and damp condition, free from encrusted mortar. Final texturing shall be achieved using equipment manufactured to produce longitudinal grooves 3mm \pm 1mm wide spaced at 20mm with a groove depth of 3mm \pm 1mm.
- .2 Grooving shall extend to within 75mm \pm 15mm of the PCCP edge. Grooving for small or irregular areas may be done by hand methods.
- .3 The surface shall be free in all cases from displaced aggregate particles and local projections.

.8 Surface Tolerance

- .1 The surface of the concrete shall be such that when tested with a 3m long straightedge, including the edge of PCCP, except across the crown or drainage gutters, there shall not be a gap greater than 5mm between the bottom of the straightedge and the surface of the PCCP.
- .2 Diamond grinding may be required to ensure the concrete surface meets these requirements.
- .3 Areas of PCCP repaired by diamond grinding will not be excluded from sampling for the determination of core compressive strength or thickness.

5.6 Curing

- .1 The Contractor shall apply one coat of an approved curing compound after the texturizing operation without damaging the PCCP surface. A second application of the approved curing compound shall be applied within thirty (30) to sixty (60) minutes after application of the first coat. Both applications shall be such that the membrane formed is of uniform thickness and colour and free of breaks and pinholes. The surface shall be maintained in this condition for a minimum of seven (7) days unless otherwise approved by the Engineer.
- .2 As soon as the forms are removed, the sides of the exposed concrete faces shall be sprayed with the white pigmented curing compound at the rate of application not less than the rate specified by the manufacturer of the compound.
- .3 Curing compound shall not be applied to joint faces receiving sealant or to concrete surfaces to which concrete or mortar is to be bonded.

5.7 Joint Sealing

.1 General

- .1 The joints shall be thoroughly cleaned of all dirt, loose mortar particles and other foreign material lodged in the joints.

- .2 Joints and the pavement surface shall be cleaned of all residue left by the sawing operation. Initial cleaning shall be done by water jet having sufficient volume and pressure to remove the residue. Alternative methods of cleaning joints must be approved by the Engineer. The joint shall be blown out with an air jet having sufficient volume and pressure to remove the residue. Joints shall be allowed sufficient time to thoroughly dry before the application of the joint sealer.
 - .3 The joint must be surface dry at the time of filling, and the ambient temperature must be at least 4°C and rising.
- .2 Sealant Installation
- .1 Transverse joints and cracks shall be filled prior to longitudinal joints. Grinding and milling operations shall be completed prior to sealant placement. Sealant shall be installed in accordance with the manufacturer's recommendations.
 - .1 Liquid Sealant
 - .1 Backer Rods
 - .1 Backer rods shall have a minimum diameter of 25% greater than the reservoir width. The Contractor shall install backer rods immediately after cleaning and before sealant installation. Backer rods shall be inserted uniformly to the required depth to achieve the required shape factor. The backer rod shall not be punctured or stretched during installation.
 - .2 Liquid Sealant Installation
 - .1 The sealant shall be placed following the installation of the backer rod by a manual pouring cone, or hose and wand fitted with proper size tip from a low pressure pump connected to the heating kettle. The tip of the cone or wand shall be placed to the top of the backer rod to ensure uniform application.
 - .2 The reservoir shall be filled with sealant so that upon cooling, the sealant shall be 3mm to 6mm recessed below the adjacent PCCP surface. If after the initial placement, the material subsides below the required recess depths, additional sealant shall be placed. Overfilling joints shall not be permitted. Overfilled joints shall have excess material removed.
 - .3 Sealant damaged by construction traffic or the Contractor's operations shall be replaced by the Contractor at the Contractor's expense.
 - .4 All spilled material or excess material in the joints or cracks shall be removed immediately and the PCCP surface cleaned.
 - .5 Joint sealing material shall not be placed when the air temperature is less than 10°C.

5.8 Miscellaneous Protection

- .1 Rain
 - .1 Concrete shall not be placed in the rain. The Contractor shall take all necessary precautions to protect plastic concrete from rain. Any damage to the PCCP caused by rain shall be repaired or PCCP replaced at the Contractor's expense.
- .2 Opening to Traffic
 - .2 The Contractor shall demonstrate that the in-situ concrete strength complies with specified minimums prior to opening to traffic. In compliance with Table 4.2.2, a proposed in-situ testing program shall be submitted to the Engineer for approval at least two weeks prior to commencement of concrete production.
 - .3 Traffic, other than foot traffic, rubber-tired saw cutting equipment, and rubber-tired side wheels of form mounted placing and finishing equipment necessary to construct

- adjacent lanes, shall not be permitted on the concrete until it has attained 20MPa compressive strength or a flexural strength of 3.2MPa.
- .4 For concrete incorporated in Full Depth Repairs of PCCP and Partial Depth Repairs of PCCP, the Contractor shall take a minimum of one (1) set of cylinders from the last load of concrete placed in the PCCP section to be opened to traffic. The test cylinders shall be field cured adjacent to the repair area. The Contractor shall test the samples. Early opening to traffic shall be in accordance with this Specification.
 - .5 The PCCP shall be protected from damage to the surface at all times when steel tracked equipment is used.
- .3 Cold Weather
- .6 Prior to the placement of any PCCP, the Contractor shall submit a detailed curing and protection plan for cold weather conditions. Cold weather conditions shall apply to any placement done between October 1 and April 1, or at any time that the air temperature is forecast to be below 0°C within seventy-two (72) hours of PCCP placement.
 - .7 No concrete shall be placed under cold weather conditions until the curing and protection plan is reviewed and approved by the Engineer.
 - .8 As a minimum, the curing and protection plan shall contain the following elements:
 - .1 The Contractor shall monitor and ensure that the minimum in-place temperature of the PCCP is 15°C for the first three days of curing, and at 10°C for the subsequent four (4) days.
 - .2 All PCCP surface and edge material shall be covered with insulated blankets.
 - .9 The plan shall describe any further methods to be used by the Contractor to ensure that the minimum concrete temperatures are met.
 - .10 All costs associated with work completed under cold weather conditions are considered incidental and no additional payment will be provided.
 - .1 Insulation Removal for Saw Cutting
 - .1 When the PCCP requires protection by insulation, no more than 25 lineal metres of PCCP shall be exposed for saw cutting operations at any one time. In no case shall any PCCP be exposed for more than one hour during saw cutting.

5.9 Full Depth Repair of PCCP

- .1 General
 - .1 Where the Contractor is required to carry out full depth repairs of PCCP, the following clauses will apply in addition to the requirements of this Specification:
- .2 Construction
 - .1 Concrete Removal
 - .1 The outer limits of the concrete removal shall be saw cut full depth. The concrete removal method shall ensure that the concrete to be removed is not broken in place and that the adjoining concrete and underlying subbase remains undisturbed. Where the existing subbase is disturbed, the loosened material shall be removed, the surface compacted and replaced with an additional depth of concrete at the Contractor's expense. The Contractor shall dispose of the concrete as approved by the Engineer.
 - .2 Joints
 - .1 Dowel Bar and Tie Bar Placement
 - .1 Gang drills shall be used to drill holes in the existing concrete for insertion of the dowel bars or tie bars. Drill holes shall be thoroughly cleaned.
 - .2 The Contractor shall secure one half of the dowel bar into the existing concrete with epoxy resin. The epoxy resin shall be injected

- into the back of the cleaned drill hole and the dowel bar, with grout retention disks attached, shall be inserted to ensure the bars are completely enveloped with epoxy resin. The other half of the dowel bar shall be coated with oil or a form release agent.
- .3 The Contractor shall secure the tie bars into the existing concrete with epoxy resin. The epoxy resin shall be injected into the back of the cleaned drill hole and the tie bars, with grout retention disks attached, shall be inserted to ensure the bars are completely enveloped with epoxy resin.
 - .2 Dowel Bars and Transverse Joints
 - .1 Where reinforcement is present, dowels may be adjusted 25mm horizontally, and raised or lowered 10mm, to avoid drilling the reinforcement.
 - .3 Transverse Joints - Contraction
 - .1 Transverse contraction joints shall be cut or formed to match existing joints or working cracks and skewed if required. Dowels or load transfer devices shall be installed at mid depth of the PCCP slab, in a plane with the PCCP surface and parallel to the centreline of the road.
 - .3 Concreting
 - .1 Placing Concrete
 - .1 Before placing concrete, it shall be demonstrated that the equipment to be used provides for proper adjustment of screeds, floats, propulsion and control equipment.
 - .2 Texturing of the Surface
 - .1 Texturing of the surface shall be in accordance with this Specification except that manual devices may be used to provide the required tined texture.
 - .2 Texturing is not required when the concrete surface is to be diamond ground as specified elsewhere in the Contract.
 - .3 Surface Tolerance
 - .1 The surface of the concrete repair shall join flush with the existing PCCP.
 - .4 Curing, Joint Sealing and Removal of Forms
 - .1 Curing, joint sealing and removal of forms for full depth repair of PCCP shall be in accordance with this Specification.
 - .5 Miscellaneous Protection
 - .1 The Contractor shall provide Miscellaneous Protection for full depth repair of PCCP in accordance with Section 5.8.
 - .6 Sampling and Testing - Slump, Air Content and Compressive Strength
 - .1 Sampling and testing for full depth repair of PCCP shall be in accordance with this Specification except that the compressive strength requirement shall be based on testing of standard cylinders with a frequency of one set of three cylinders for each fifteen (15) cubic metre unit of concrete but not less than one (1) set of cylinders per day.
 - .7 Removal of Unacceptable Concrete
 - .1 Concrete found to be unacceptable shall be removed and replaced with new material at the Contractor's expense.
 - .8 Criteria for Determining Unacceptable Concrete
 - .1 If the tests on cylinders do not show a twenty-eight (28) day compressive strength of the greater of 32MPa or the compressive strength established in Section 3, the area represented by the cylinders shall be removed and replaced at the Contractor's expense.

5.10 Partial Depth Repairs in PCCP

.1 General

- .1 Where the Contractor is required to carry out partial depth repairs of PCCP, the following clauses will apply in addition to the requirements of this Specification

.2 Construction

.1 General

- .1 The Consultant shall clearly delineate the limits of the repair area. The perimeter of the PCCP repair area shall be saw cut vertically to a depth of 50 mm. The concrete within the saw cut area shall be removed to a minimum depth of 50 mm and a maximum depth of one-third of the thickness of the existing concrete slab using equipment that prevents the fracture of the underlying sound concrete.
- .2 The area shall be abrasive blast cleaned in accordance with this Specification. Immediately prior to filling the repair area with concrete, the surface area of the repair shall be uniformly coated with cement paste. The cement paste shall consist of normal Portland cement, and sufficient water to produce a paste that can be applied with a brush. Cement paste not used within thirty minutes shall be discarded. The repair area shall then be filled with concrete, finished flush with the adjacent surface and cured in accordance with this Specification.

.2 Joints and Working Cracks

- .1 Where the partial depth repair area includes an existing PCCP joint or working crack, a joint shall be formed in the repair area to match the existing PCCP joint or working crack. The joint shall be formed by placing a compressible joint material along the cut line in such a manner that prevents the plastic concrete from infiltrating the existing joint or crack. The width of compressible material shall match the existing joint or working crack. Prior to placement of compressible material, joints or working cracks shall be blown clean with compressed air.

.3 Miscellaneous Protection

- .1 The Contractor shall provide Miscellaneous Protection for partial depth repairs in PCCP in accordance with Section 5.8.

.4 Sampling and Testing - Slump, Air Content and Compressive Strength

- .1 Sampling and testing for partial depth repair of PCCP shall be in accordance with this Specification except that the compressive strength requirement shall be based on testing of standard cylinders with a frequency of one set of three cylinders for each fifteen (15) cubic metre unit of concrete but not less than one (1) set of cylinders per day.

.5 Removal of Unacceptable Concrete

- .1 Concrete found to be unacceptable shall be removed and replaced with new material at the Contractor's expense.

.6 Criteria for Determining Unacceptable Concrete

- .1 If the tests on cylinders do not show a twenty-eight (28) day compressive strength of the greater of 32MPa or the compressive strength established in Section 3, the area represented by the cylinders shall be removed and replaced at the Contractor's expense.

6. END PRODUCT ACCEPTANCE OR REJECTION

6.1 General

- .1 The Contractor shall provide an end product conforming in quality and accuracy of detail to the dimensional and tolerance requirements of the Specifications and Drawings. Where

no tolerances are specified, the standard of workmanship shall be in accordance with normally accepted good practice.

6.2 End Product Acceptance at Full or Adjusted Payment

- .1 Acceptance of any Lot at full or increased payment will occur if it contains no obvious defects and if:
 - .1 For twenty-eight (28) day compressive strength, full payment will be made if the Lot Mean compressive strength is greater than or equal to the greater of 32MPa, or the compressive strength established in Section 3.
 - .2 For thickness, full payment will occur if the Lot Mean for thickness falls between -2mm and +2mm of the specified thickness and increased payment will be made if the Lot Mean for thickness in the Lot is 3mm or greater.
 - .3 For smoothness, full payment will occur if the Surface Tolerance of all Sublots in the PCCP Lot are within specified limits.
 - .4 Individual bumps and dips do not exceed 8mm.
- .2 Acceptance at Reduced Payment of any Lot will occur if it contains no obvious defects and if:
 - .1 The test results are such that the Lot or Sublot meets with the requirements for acceptance at a reduced payment.
 - .2 The Lot or Sublot is approved in respect of all other requirements.
 - .3 The Contractor has not notified the Engineer in writing that he will exercise his option to repair or remove and replace the Work at his own cost with work meeting the requirements for acceptance at full or increased payment.
 - .4 Individual bumps and dips measuring 12mm or greater have been repaired.
 - .5 Individual bumps and dips exceeding 8mm and less than 12mm which have been designated by the Engineer as unacceptable, have been repaired.
- .3 Both bonus and penalty adjustments may be made for any Lot in accordance with Section 7, Measurement and Payment.

6.3 End Product Rejection

- .1 If the Lot Mean for compressive strength or thickness are outside the applicable acceptance limits, then the Lot is rejected automatically, regardless of the values of the other control characteristics.
- .2 If more than 50% of the Surface Tolerance tests of any PCCP Sublot exceeds the specified limits, the Sublot or an area delineated at the discretion of the Consultant may be rejected.
- .3 The finished surface of the PCCP shall have a uniform texture and be free of visible signs of poor workmanship. Any obvious defects as determined by the Consultant such as, but not limited to the following, will be cause for automatic rejection of PCCP regardless of the values of any other control characteristic.
 - .1 Individual bumps and dips 12mm or greater. The Engineer may reject PCCP with individual bumps and dips exceeding 8mm and less than 12mm.
 - .2 Segregated and or spalled areas.
 - .3 Improper joints.
 - .4 Footprints and other marks.
 - .5 Cracking.
 - .6 Sampling locations not properly reinstated.

- .7 Improperly constructed patches or repairs.
 - .8 Individual core(s) with a thickness deficiency exceeding 25mm.
 - .9 Any concrete damaged due to freezing or rain.
- .4 When PCCP is rejected by reason of obvious defects, the minimum area of rejection will be one panel size or as determined by the Engineer.
- .5 When PCCP is rejected for an individual core with a thickness deficiency exceeding 25mm the Contractor shall undertake exploratory coring, in the presence of the Engineer, to determine the limits of the thickness deficiency. The exploratory cores will be at the same offset as the deficient core and shall be taken at 5m intervals on each side of the station of the deficiency core. The limits of thickness deficiency shall occur at the first station, on each side of the original reject core, where the thickness of the exploratory core is not deficient by more than 20mm. The limits for repair shall further extend to the next transverse joint.
- .6 Rejected work shall be promptly repaired or removed and replaced in accordance with Section 5.9 or Section 5.10. The Engineer shall test the new PCCP Lot in accordance with the requirements of Section 4.3 with modifications as outlined in Section 5.9. The Contractor shall be responsible for all costs.
- .7 No payment will be made for work in any PCCP Lot or PCCP Sublot which has been rejected until the defects have been remedied.

6.4 Repairs in PCCP

- .1 All obvious defects, including cracking, shall be repaired using a full depth repair in accordance with Section 5.9.
- .2 For instances where the cracking is greater than 50mm but no more than one-third the depth of the PCCP slab, or the obvious defects are confined to the pavement surface, a partial depth repair may be used in accordance with Section 5.10 with the approval of the Engineer.
- .3 Alternative repair methods for obvious defects of minor severity or frequency may be used with the approval of the Engineer.

7. MEASUREMENT AND PAYMENT

The unit prices for the following items of work shall be full compensation for all labour, material, tools, equipment and incidentals necessary to complete the work in accordance with these Specifications.

7.1 Portland Cement Concrete Pavement – EPS

- .1 Accepted PCCP will be measured in square metres and will be paid at the unit price bid per square metre for "Portland Cement Concrete Pavement - EPS" subject to the unit price adjustments hereinafter specified. This payment will be full compensation for supplying and installing load transfer devices and tie bars; for supplying and placing the Portland cement concrete; all quality control testing, coring, and core hole filling for quality assurance samples; all materials and expenses for form work, curing, texturing and protection; and all materials and expenses related to the forming and sealing of joints; and all expenses related to cold and hot weather concreting.

- .2 Payment for Acceptable Work
 - .1 The following end product properties of "Portland Cement Concrete Pavement - EPS" will be measured for acceptance in accordance with these Specifications.
 - .1 28 Day Core Compressive Strength
 - .2 Thickness
 - .3 Smoothness
- .3 Unit Price Adjustment for 28 Day Core Compressive Strength
 - .1 The unit price adjustment for 28 Day Core Compressive Strength will be the applicable amount shown in Table 7.2.1 for the Lot Mean 28 day Core Compressive Strength. Any unit price adjustment so determined will decrease the payment owing for Portland Cement Concrete Pavement - EPS.
 - .2 Contrary to Section 4.4.6.7 Compressive strength requirements of the latest edition of CAN/CSA-A23.1-04, no adjustment to the compressive strength criteria will be provided for either cylinder formed or cored pavement samples.
- .4 Unit Price Adjustment for Thickness
 - .1 When the cores in the PCCP Lot are located in sections where the PCCP design thickness is not constant, the specified thickness (t) for each core shall be adjusted based on the core offset (co) according to the following equation: $t(\text{adj}) = 240 + 13.51(\text{co})$, where co=core offset in metres from centreline, and $t(\text{adj})$ = adjusted specified thickness in "mm". The Lot specified thickness shall be the average of the adjusted specified thickness for all cores. The Lot mean thickness shall remain as the average measured value.
 - .2 The specified thickness and Lot Mean thickness as calculated above will be recorded to the nearest whole millimetre. Coring for thickness will not be undertaken on the inside shoulder on transitions between normal crown and super elevation as determined by the Consultant.
 - .3 The unit price adjustment for thickness will be the applicable amount shown in Table 7.2.2 for the Lot Mean thickness. Any unit price adjustment so determined will increase or decrease the payment owing for Portland Cement Concrete Pavement - EPS.
- .5 Unit Price Adjustment for Smoothness
 - .1 The unit price adjustment for Smoothness will be the applicable amount shown in Table 7.2.3 for the Surface Tolerance of that PCCP Sublot. Any unit price adjustment so determined will be deducted from the payment made for Portland Cement Concrete Pavement EPS.
 - .2 Every PCCP Sublot that is outside the acceptance limit for Smoothness will be rejected and payment will not be made for the quantity of PCCP in these PCCP Sublots until they have been made acceptable. Payment for the remainder of the PCCP Lot will be made in accordance with the above, using the applicable unit price adjustment for 28 day Core Compressive Strength and thickness as determined for the PCCP Lot, to which will be added, or from which will be subtracted, any adjustment for Smoothness.
- .6 Payment for Work That Had Been Rejected, But Was Made Acceptable

When defects have been remedied in PCCP Lots or PCCP Sublots that had been rejected, payment for the original quantity of material in those PCCP Lots or PCCP Sublots will be made subject to unit price adjustments determined as follows:

 - .1 The unit price adjustment for Core Compressive Strength and thickness will be based upon testing of the replacement material. Where replacement material does not cover the entire PCCP Lot or PCCP Sublot, prior tests to the uncovered area will be averaged with new tests on the corrective work.
 - .2 Unit price adjustments for smoothness will be made as follows:

- .1 Unit price adjustments for Surface Tolerance will be determined from Section 7.1.4 and will be based upon field tests following the Contractor's corrective efforts for any bumps and dips. Core compressive strength and thickness test results from the PCCP Lot or PCCP Sublot in which the smoothness was initially deficient will be used to determine the new unit price adjustment.
- .2 Unit price adjustments for bumps and dips will be \$3,000 for each individual bump or dip over 8mm and will be based upon initial Surface Tolerance testing conducted by the Engineer. Repairs carried out by the Contractor shall not affect the lump sum adjustment for smoothness.
- .3 The unit price adjustment determined through retesting of the corrective work will be applied to that quantity of material in the PCCP Lot or PCCP Sublot which was originally rejected, to determine payment.
- .3 No payment will be made for additional coring and testing to determine the limits of slab removal. No payment will be made for any material used to replace or repair rejected work and all corrective work shall be performed entirely at the Contractor's expense.
- .4 The Owner will pay for re-coring and testing of strength and thickness only when the retests result in an increase in payment.

Table 7.2.2 - Unit Price Adjustment for 28 Day Core Compressive Strength

Lot Mean			Unit Price Adjustment (\$ / m ²)
(MPa)		(MPa)	
$m \leq$	f(c)		0
$m - 1 \leq$	f(c)	< m	-1.0
$m - 2 \leq$	f(c)	< m - 1	-2.0
$m - 3 \leq$	f(c)	< m - 2	-3.0
$m - 4 \leq$	f(c)	< m - 3	-5.0
$m - 5 \leq$	f(c)	< m - 4	-8.0
$m - 6 \leq$	f(c)	< m - 5	-9.0
$m - 7 \leq$	f(c)	< m - 6	-10.0
	f(c)	< m - 7	REJECT

where f(c) = 28 Day Core Compressive Strength. Actual age of the samples is targeted to be, but may exceed, 28 Days.

m = 32MPa, or the compressive strength established in Section 3.

Table 7.2.3 - Unit Price Adjustment for Core Thickness

Lot Mean			Unit Price Adjustment (\$ / m ²)
(mm)		(mm)	
	d	> t + 7	0.5
t + 6 =	d	= t + 5	0.38
t + 4 =	d	= t + 3	0.25
t + 2 =	d	= t - 2	0
t - 4 =	d	= t - 3	-1.0
t - 6 =	d	= t - 5	-1.5
t - 8 =	d	= t - 7	-2.0
t - 10 =	d	= t - 9	-2.5
t - 12 =	d	= t - 11	-3.0
t - 14 =	d	= t - 13	-3.5
t - 16 =	d	= t - 15	-4.0
t - 18 =	d	= t - 17	-4.5
t - 20 =	d	= t - 19	-5.0
	d	> t - 20	REJECT

where t = specified thickness (mm)
d = Lot Mean thickness (mm)

Table 7.2.3 – Lump Sum Sublot Adjustment for PCCP Smoothness

% of Sublot Area Tests Exceeding Surface Tolerance	Adjustments for Smoothness (\$ per PCCP Sublot Lump Sum)
10	\$0
10-20	-\$1,000
20-30	-\$2,000
30-40	-\$3,000
40-50	-\$5,000
>50	REJECT

END OF SECTION