1.0 GENERAL

1.1 Scope

1.1.1 This specification shall cover the preparation of Portland Cement Concrete for, and all concreting operations relating to, the construction of Portland Cement Concrete pavements, curbs, gutters, private approaches, bullnoses, median slabs and other related concrete works.

1.1.2 The work to be done by the Contractor under this Specification shall include the supply of all materials, and the furnishing of all superintendence, overhead, labour, equipment, tools, supplies and all other things necessary for and incidental to the satisfactory performance and completion of all work as hereinafter specified.

1.1.3 Where a Standard is referenced in this specification, the current version of that standard shall apply.

2.0 PRODUCTS

2.1 General

2.1.1 The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this specification.

2.2 Cement

2.2.1 All cement shall be either Type 10 Normal Portland Cement or Type 30 High Early Strength Portland Cement conforming to the requirements of CAN/CSA-A5.

2.2.2 Cement shall be kept in weatherproof storage that will protect it from moisture and contamination, and in such a manner as to permit inspection, sampling and identification, where required, of each lot.

2.2.3 Check tests of cement which has been previously approved by the Engineer will be made from time to time by the Engineer and any cement which fails to comply with the requirements of CAN/CSA-A5 will be rejected, notwithstanding any certificate of acceptance that may have been previously given. Cement which has been rejected must be removed immediately by the Contractor.

2.3 Pozzolans

2.3.1 Pozzolanic materials such as Fly Ash shall conform to CAN/CSA-A23.5-M86, Supplementary Cementing Materials. The mass

of the pozzolan shall not exceed 20% of the total mass of Cementitious Material. Its use shall be limited to concrete placed not earlier than May 1, or later than September 15, of each work season.

2.4 Water

2.4.1 Water used for mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. It shall be equal to potable water in physical and chemical properties.

2.5 Aggregates

2.5.1 The Contractor shall furnish in writing to the Engineer the location of the sources where aggregate will be obtained in order that same may be inspected and tentatively approved by the Engineer. Changes in the source of aggregate supply during the course of the contract will not be permitted without notification in writing to and the express approval of the Engineer.

2.5.2 Fine aggregate shall conform to the requirement of CAN/CSA-A23.1-M90, Section 5, Aggregates.

2.5.3 Coarse Aggregate shall conform to the requirements of CAN/CSA-A23.1-M90, Section 5, Aggregates.

2.5.4 The grading of coarse aggregates shall conform to the requirements of Table 2, Group 1 Aggregate, CAN/CSA-A23.1-M90.

2.6 Admixtures

2.6.1 No admixture, other than Air-Entraining Agent and Type WN Water-Reducing Agent, shall be used without the written authorization of the Engineer, unless otherwise specified in the Special Provisions.

2.6.2 The air entraining agent shall conform to the requirements of CAN3-A266.1-M78. The water-reducing agent shall be Type WN and shall conform to the requirements of CAN3-A266.2-M78.

2.7 Storage of Material

2.7.1 All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Engineer. Storage of materials shall be in accordance with the requirements of CAN/CSA3-A23.1-M90, Section 9, Storage of Materials, except as otherwise specified herein.

2.8 Joint Sealer

2.8.1 The joint sealer shall be a hot-poured elastic type and shall conform to the requirements of ASTM Standard D 3405, Specification for Joint Sealants, Hot-poured, for Concrete and Asphalt Pavements.

2.9 Fibre Joint Filler

2.9.1 Fibre joint filler shall be rot-proof and of the preformed, non-extruding, resilient type made with a bituminous fibre and shall conform to the requirements of ASTM Standard D 1751, Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

2.10 Reinforcing Steel

2.10.1 All reinforcing steel shall be supplied according to the type and dimensions as shown on the Drawings.

2.10.2 All reinforcing steel shall conform to the requirements of CSA Standard G30.12-M, Billet-Steel Bars for Concrete Reinforcement. If, in the opinion of the Engineer, any reinforcing steel provided for the concrete works exhibits flaws in manufacture or fabrication, such material shall be immediately removed from the site and replaced with acceptable reinforcing steel.

2.10.3 The reinforcing steel shall be supplied in accordance with the following requirements:

.1 Tie Bars shall be Grade 40 deformed bars.

.2 Dowel Bars shall be Grade 40 plain bars.

.3 Bar Accessories shall be of a type approved by the Engineer.

2.10.4 All reinforcing steel shall be straight and free from paint, oil, mill scale and injurious defects. Rust, surface seams or surface irregularities will not be cause for rejection provided that the minimum dimensions, cross-sectional area and tensile properties of a hand wire-brushed specimen are not less than the requirements of CSA Standard G30.12M.

2.11 Epoxy Coating

2.11.1 Epoxy Coating material shall be Scotchcote 213, fusion bonded epoxy coating as manufactured by the 3M Company or approved alternate.

2.11.2 The coating shall meet the following general requirements:

.1 ASTM G14-72 Impact Resistance of Pipeline Coatings - Falling Weight Test.

.2 FHWA - NEEP No. 16

.3 ASTM C-1044-73 Resistance of Transparent Plastics to Surface Abrasion.

.4 ASTM G17-72 Penetration Resistance of Pipeline Coatings.

.5 ASTM G8-72 Cathodic Disbonding of Pipeline Coating.

2.11.3 Coating thickness shall be 175 ± 50 Micrometres.

2.11.4 Continuity of Coating

.1 The coating shall be checked visually after cure for continuity. It shall be free from holes, voids, contamination, cracks, and damaged areas.

.2 The coating shall not have more than two holidays (pinholes not visible to the naked eye) in any linear foot of the coating bars. Holiday checks shall be made with a 67.5-volt holiday detector in accordance with the manufacturer's instructions.

.3 In the event that construction methods and techniques result in damage to the continuity of the epoxy coating on reinforcement steel, such as might occur through field bending of longitudinal tie bars, such damage shall be repaired using the same type of epoxy coating material as was used in the original coating operation.

2.12 Liquid Membrane-Forming Curing Compound

2.12.1 Curing compound shall be white-pigmented liquid membrane-forming curing compound conforming to the requirements of CGSB Standard 90-GP-la.

2.13 Polyethylene Film

2.13.1 Polyethylene film shall be clear or white opaque and conform to the requirements of ASTM Standard C171.

2.14 Form Coating

2.14.1 Form coating shall be of a type approved by the Engineer.

2.15 Miscellaneous Materials

2.15.1 Miscellaneous materials shall be of the type specified on the Drawings or approved by the Engineer.

2.16 Design Requirements

2.16.1 Mix Design Statement

.1 For each type of concrete to be used, the Contractor shall provide the Engineer with a Mix Design Statement certifying the constituent materials and mix proportions that will be used in the Portland Cement Concrete. The Contractor shall also supply evidence to the Engineer that the mix proportions selected will produce concrete of the specified strength, workability and yield.

.2 A water-reducing agent as approved by the Engineer and not exceeding the manufacturer's recommended quantity may be used. Where additional dosage of admixture is required, written approval shall be obtained from the Engineer.

.3 This Mix Design Statement shall be submitted to the Engineer at least one (1) week prior to the delivery of any concrete to the job site. Once approved by the Engineer, all concrete shall be supplied in accordance with this Statement, which shall be called the Job Mix Formula.

.4 No changes in the Job Mix Formula will be permitted without following the above procedure.

2.16.2 Concrete Strength and Workability

.1 Proportioning of fine aggregate, coarse aggregate, cement, water, air-entraining agent and water-reducing admixture shall be such as to yield concrete having the required strength and workability, as follows:

.2 Concrete for Pavements, Commercial Approaches, Curb and Gutter Sections, Curbs and Bullnoses

.3 Specified Compressive Strength @ 28 days of 32 MPa

.4 Minimum Cementitious Materials content = 320 kg/m.^{3} Type 10 or Type 30, Portland Cement, including no more than 20% by mass of approved pozzolan.

.5 Maximum Water/Cement Ratio = 0.45

.6 Maximum Slump = 80 mm

.7 Aggregate Size: Maximum 28 mm nominal

.8 Air Content: 6.5% ± 1%

2.16.3 Concrete for Early Opening of Pavements

.1 It shall be the responsibility of the Contractor to modify the mix design, as required, in order to ensure that the minimum compressive strength of the concrete pavement is 20 MPa and is achieved within the early opening requirements of the Contract.

.2 The mix design statement for this concrete shall be submitted to the Engineer in accordance with clause 2.16 Design Requirements of this Specification. Either Type 10 or Type 30 Portland Cement may be used in attaining this higher earlier strength. Other conditions of clause 2.16 Design Requirements, shall apply.

.3 The concrete cylinders used to test the compressive strength of the concrete pavement for the purpose of determining the early opening requirements shall be placed in a curing box and shall remain on site near the location in which the concrete pavement was placed until the cylinders are to be tested. Samples for quality control shall continue to be lab cured and tested.

2.17 Concrete Supply

2.17.1 Unless otherwise specified in the Special Provisions of the Contract, the use of a ready-mixed concrete plant only will be permitted. Concrete shall be proportioned, mixed and delivered in accordance with the requirements of CAN/CSA-A23.1-M90, Section 18, Production of Concrete, except that the transporting of ready-mixed concrete in non-agitating equipment is not permitted without the written permission of the Engineer.

2.17.2 The discharge of ready-mixed concrete from the transit mixer shall be completed within 1and 1/2 hours after the introduction of the mixing water to the cement and aggregates, unless an extension of time is authorized by the Engineer.

2.17.3 All delivery tickets shall indicate the time of batching.

2.17.4 The Contractor shall maintain all equipment used for handling and transporting the concrete in a clean condition and proper working order.

3.0 EXECUTION

3.1 Equipment

3.1.1 All equipment shall be of a type approved by the Engineer. The equipment shall be in good working order, kept free from hardened concrete or foreign materials, and shall be cleaned at frequent intervals.

3.1.2 The Contractor shall at all times have sufficient standby equipment available on short notice.

3.2 Sub-grade, Sub-base and Base Course Construction

3.2.1 No concrete work shall commence until the construction of sub-grade, sub-base course and granular base course has been completed and has been approved by the Engineer.

3.2.2 Granular base course shall be specified by the Engineer.

3.3 Forms

3.3.1 Forms for concrete shall be constructed of steel or wood and shall be sufficiently rigid to prevent lateral or vertical distortion from the loading environment to which the forms will be subjected. All forms shall be set to the design grades, lines and radii as shown on the Drawings. Forms shall be adequately anchored and firmly set in continuous contact with the compacted sub-base to prevent displacements 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.

3.3.2 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.

3.3.3 Forms shall not be removed for a period of at least twenty-four (24) hours after the concrete placement has been completed. Removal of forms shall be done in a careful and workmanlike manner in order to avoid damage to, or spalling of, the concrete.

3.3.4 Placement of Portland cement concrete pavement by formed methods shall be permitted only at locations designated on the Drawings and areas too small to permit slip form paving.

3.3.5 Forms shall be of suitable cross section and strength and adequately secured 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.

3.3.6 All side forms for this work shall be of metal. These shall be of shaped steel sections and shall be of a depth at least equal to the edge thickness of

the work prescribed and shall have a base equalling 80 percent of the height of the form with a minimum base width of 150 mm. The forms shall be free from warps, bends or kinks. Approved flexible forms shall be used for construction where the radius is 60 metres or less.

3.4 Placing Reinforcing Steel

3.4.1 All reinforcing steel shall be positioned as shown on the Drawings and shall be held in place by positive and satisfactory means so that the correct position of the reinforcing steel will be maintained after the concrete has been placed, vibrated and finished. If reinforcing steel is displaced during concrete placing operations, concrete placement shall cease and shall not resume until the displaced reinforcing steel has been reset to its true design position.

3.4.2 Once all reinforcing steel is in position, it 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.

3.4.3 Where the Drawings call for a new slab to be tied to an existing slab, the Contractor shall install tie-bars into the existing slab in the following manner.

3.4.4 Holes 16 mm in diameter and a minimum of 230 mm deep shall be drilled into the existing pavement at the spacings shown on the Drawings. Particular care shall be taken to ensure that no damage to the pavement results from such drilling operation. Any damage shall be repaired at the Contractor's expense to the satisfaction of the Engineer.

3.4.5 Holes shall be thoroughly cleaned and dried prior to installation of epoxy. Epoxy, as approved by the Engineer, shall be mixed in accordance with manufacturer's instructions.

3.4.6 Using a method approved by the Engineer, the hole shall be thoroughly coated with epoxy. A 15M tie-bar shall then be driven into the prepared hole.

3.5 Joints

3.5.1 Contraction, isolation and construction joints shall be constructed, where required, in accordance with details shown on the Drawings or as directed by the Engineer. All joints in pavement slabs shall be vertical and continuous through the curbs.

3.5.2 Isolation joints shall be constructed only where directed by the Engineer. A 15 mm thick fibre joint filler shall be installed in isolation joints. The

fibre joint fill shall extend from the base of the concrete slab up to 10 mm below the concrete surface. All isolation joints shall be edged with an approved tool to assure no concrete bridges across the joint filler.

3.5.3 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.

3.5.4 Contraction joints shall be saw cut by approved methods to the dimensions 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, normally within 6 to 24 hours after placement. The Contractor shall be wholly responsible for all concrete defects arising from this operation and shall further correct or replace all such defective concrete as may be required in the opinion of the Engineer. The costs of all corrective measures shall be borne entirely by the Contractor and rejected concrete shall be removed by and at the expense of the Contractor clear of the site of the work.

3.5.5 Immediately after the sawing of each joint, the joint and the pavement surface shall be cleaned of all residue left by the sawing operation. When the joint is wet cut, the cleaning shall be done by water jet having sufficient volume and pressure to remove the residue. Alternative methods of cleaning joints which have been wet cut must be approved by the Engineer. When the joint is dry cut, the cleaning shall be done by air jet having sufficient volume and pressure to remove the residue.

3.5.6 Longitudinal joints shall be either formed or saw-cut. When longitudinal joint is saw-cut, the Contractor shall ensure that any residue cleaned from the longitudinal joint does not go into the previously cleaned contraction joints.

3.6 Concrete Placement

3.6.1 No concrete shall be placed until the Engineer has examined and approved the layout of the forms, dowels, tie bars and joints, and the condition and grade of the compacted base course. Concrete placement may not proceed when ambient air temperatures are below 5 ^{o}C.

3.6.2 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 ^{o}C or greater than 30 ^{o}C, as measured at time of placing.

3.6.3 Concrete delivery vehicles will not be permitted to travel on the prepared base if, in the opinion of the Engineer, damage to the base is observed to occur.

3.6.4 Concrete shall be placed within 90 minutes of batching and before it has taken its initial set. Retempering will be permitted only under the conditions specified in Section 18.4.3, Control of Slump and Air Content, of CAN/CSA-A23.1-M90.

3.6.5 Concrete shall be deposited in the forms as nearly as practicable to its final position in a rapid and continuous operation in such a manner as to require as little rehandling as possible and to avoid segregation and separation of the materials.

3.6.6 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.

3.6.7 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.

3.6.8 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.

3.6.9 Concrete shall be worked thoroughly around any reinforcement, and around embedded fixtures and into the angles and corners of the forms. During placement, concrete shall be sufficiently vibrated with suitable equipment to secure close bond with the reinforcement, 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.

3.6.10 Once the placing and vibrating of the concrete has been completed, the forms, shall not be jarred, and any projected reinforcing steel shall not be disturbed, for a period of at least twenty-four (24) hours.

3.6.11 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. 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. 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.

3.6.12 The Machine Placed Portland Cement Concrete shall be placed by slip form pavers. The paver and related equipment shall place the pavement to the full depth, width, crown, and grade shown on the Drawings.

3.6.13 The slip form paver shall spread, consolidate, screed, and float finish the concrete in one pass.

3.6.14 The slip form paver shall be self-propelled and shall be mounted on two sets of crawler treads each not less than 250 mm wide and 6.5 metres 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. 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. Where it is necessary to operate the paver on adjacent pavement, the propelling mechanism must be rubber tired or the pads of the paver protected to prevent damage to the pavement.

3.6.15 The paver shall be equipped with:

.1 A mechanically operated primary strike-off which conveys the concrete to the vibratory mechanism.

.2 A vibrator and tamping bar extending over the full width of the pavement and operating behind the strike-off with a frequency of not less than 3,600 VPM.

.3 An extrusion plate not less than 1 metre in width (measured longitudinally with the pavement); set with its leading bullnosed edge higher than the trailing edge so that the concrete is extruded under compression.

.4 A rubber belt no less than 600 mm wide, set behind the oscillating extrusion plate and operated with a lateral movement of 100 mm to 200 mm.

.5 A suitable mechanism to provide automatic control of line and grade while sensing a grade line.

3.6.16 The slip forms on opposite sides of the pavement shall be connected laterally above the pavement and the forms by cross frames of a type which will assure rigidity. Forms shall extend the full depth of pavement, and the face of the forms shall not have an inward slope (or batter) of more than 15 vertical to 1 horizontal. The forms shall be of sufficient

length that the concrete will remain stable and rigid at the edges by the time the forms have passed.

3.6.17 Slip form pavers not complying with the specified requirements are subject to written approval by the Engineer prior to their use.

3.7 Edge slump

3.7.1 Edge slump shall be controlled to less than 15 mm except where abutting pavement is to be placed adjacent to that edge. In such cases, edge slump shall be restricted to less than 8 mm.

3.8 Concrete Finishing

3.8.1 Before initial set has begun, the sequence of operations shall be the strike off and consolidation floating if necessary, straight-edging, and final surface texturing.

3.8.2 After the pavement has been consolidated and struck off, it shall be scraped with a 3 metre long straight-edge equipped with a handle to permit operation from the edge of the pavement. The straight edge shall be operated parallel to centre line of the pavement and shall be moved forward one-half to length after each pass across the slab width. Irregularities shall be corrected by adding or removing concrete. All disturbed areas shall be again straight-edged. The use of long handled bull-floats shall be confined to a minimum; they may be used in areas not accessible to finishing equipment or in emergency situations.

3.8.3 Following straight-edging, the edges of all concrete placed shall be carefully finished with an appropriate edging tool. The entire surface shall be textured by a steel or fibre broom or a type approved by the Engineer drawn across the plastic concrete surface at right angles to the direction of traffic. Surface depressions introduced by brooming operations shall not be more than 3 mm deep.

3.9 Concrete Curing

3.9.1 Immediately following concrete finishing, the surface of the concrete shall be treated with a liquid membrane-forming curing compound. The rate of application shall not be less than that recommended by the manufacturer. The Contractor shall be responsible for assuring complete coverage of all exposed concrete surfaces.

3.9.2 As soon as the side forms are stripped, the edges of all concrete slabs shall be sprayed. In the case of slip form paving, the edges shall be treated at the same time as the pavement surface. Care should be taken not to apply curing compound to exposed reinforcing steel.

3.9.3 Liquid membrane-forming curing compound shall not be used when the pavement is otherwise protected from cold weather by polyethylene film.

3.10 Joint Sealing

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

3.10.2 After this cleaning and immediately before applying the joint sealer, the joint shall be blown out with an air jet having sufficient volume and pressure to remove dust and loose material remaining after the cleaning operation.

3.10.3 The joint shall then be filled with joint sealer to the depth shown on the Drawings. Overfilling of joints shall be avoided.

3.10.4 The joint must be surface dry at the time of filling, and the ambient temperature must be at least 4 ^{o}C and rising.

3.11 Climatic Conditions

3.11.1 The Contractor shall be responsible for taking all necessary measures to protect freshly laid concrete from climatic conditions including hot weather, wind, rain, sleet, snow and cold weather, to the satisfaction of the Engineer.

3.11.2 Concrete shall be adequately protected from freezing for a minimum of seven (7) days after completion of placing operations, or longer as required to ensure that the pavement opening requirements of this Specification are met. Protection shall be provided such that the surface of the concrete is maintained a minimum temperature of 10 ^{o}C for the period specified.

3.11.3 Concrete damaged as a result of inadequate protection against climatic conditions shall be removed and replaced by the Contractor at his own expense.

3.12 Opening to Traffic

3.12.1 In no case shall traffic or construction equipment be allowed on the pavement until the concrete has reached a minimum compressive strength of 20 MPa as determined by field cured cylinders.

3.12.2 If an early opening requirement is included in the Contract, a compressive strength of 20 MPa shall be attained within the specified opening time.

3.12.3 Also, before the pavement may be opened to traffic and/or before the Contractor may commence boulevard grading operations, the pavement joints shall be filled with joint sealer in accordance with clause 3.10 Joint Sealing of this specification.

3.12.4 The Engineer's decision as to when the pavement will be opened to traffic or construction equipment shall be final.

4.0 ACCEPTANCE

4.1 Inspection, Testing and Approval

4.1.1 All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Engineer or by the Testing Laboratory designated by the Engineer including all operations from the selection and production of materials through to final acceptance of the specified work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Engineer reserves the right to reject any materials or works which are not in accordance with the requirements of this Specification.

4.1.2 There shall be no charge to the Owner for any materials taken by the Engineer for testing purposes.

4.1.3 Testing, frequency and interpretation of tests on all materials shall conform to CAN/CSA-A23.1-M90 or as superceded in this specification.

4.1.4 All materials shall be approved by the Engineer at least ten (10) days before any construction is undertaken. If, in the opinion of the Engineer, such materials, in whole or in part, do not conform to the Specification detailed herein or are found to be defective in manufacture or have become damaged in transit, storage or handling operations, then such materials shall be rejected by the Engineer and replaced by the Contractor at his own expense.

4.2 Access

4.2.1 The Engineer shall be afforded full access for the inspection and control testing of concrete and constituent materials, both at the site of work and at any plant used for the production of concrete, to determine whether the concrete is being supplied in accordance with this specification.

4.3 Materials

4.3.1 All materials shall conform to CAN/CSA-A23.1-M90.

4.4 Concrete Quality

4.4.1 Quality control tests will be used to determine the acceptability of the concrete supplied by the Contractor.

4.4.2 The Engineer shall obtain samples of concrete and of the constituent materials required for quality control tests.

4.4.3 The frequency and number of concrete quality control tests shall be determined by the Engineer but not less than stated in the requirements of CAN/CSA-A23.1-M90.

4.4.4 An outline of the quality control tests is as follows:

.1 Samples of concrete for all slump, air and strength tests shall be taken in accordance with CAN/CSA-A23.1-M90 (CSA Test Method A23.2-1C, Sampling Plastic Concrete).

.2 Slump tests shall be made in accordance with CSA Test Method A23.2-5C, Slump of Concrete. If the measured slump falls outside the limits, specified in clause 2.16 Design Requirements of this Specification, a second test shall be made. In the event of a second failure, the Engineer reserves the right to refuse the use of the batch of concrete represented. A slump test will be made with every strength test.

.3 Air content determinations shall be made in accordance with CSA Test Method A23.2-4C, Air Content of Plastic Concrete by the Pressure Method. If the measured air content falls outside the specified limits, a second test shall be made at any time within the specified discharge time limit for the mix. In the event of a second failure, the Engineer reserves the right to reject the batch of concrete represented. An air determination shall be made with every strength test.

.4 Test specimens shall be made and cured in accordance with CSA Test Method A23.2-3C, Making and Curing Concrete Compression and Flexure Test Specimens.

.5 Compressive strength tests of laboratory cured cylinders at twenty-eight (28) days shall be the basis for acceptance of all concrete supplied by the Contractor. For each twenty-eight (28) days strength test, the strength of two companion standard-cured test specimens shall be determined in accordance with CSA Test Method A23.2-9C, Compressive Strength of Cylindrical Concrete Specimens, and the test result shall be the average of the strengths of the two specimens. Reduced payment for understrength

concrete shall be made in accordance with Section 2500.

.6 Compressive strength tests on specimens cured under the same conditions as the concrete works shall be made to check the strength of the concrete so as to determine if the pavement may be opened to traffic; and also to check the adequacy of curing and/or cold weather protection. For each field-cured strength test, the strength of two field-cured test specimens shall be determined in accordance with CSA Test Method A23.2-9C, Compressive Strength of Cylindrical Concrete Specimens, and the test result shall be the average of the strengths of the two specimens.

4.5 Addition of Water

4.5.1 For low-slump concrete used in slip formed paving only, water may be added to the transit mixer only under the supervision of the supplier's testing laboratory, provided the requirements for concrete quality are maintained. Once water is added the mixer drum shall be rotated 30 times at mixing speed and the slump and air tested before discharge.

4.6 Corrective Action

4.6.1 Acceptance criteria for compressive strengths of laboratory cured cylinders shall conform with Sections 17.5 and 17.6 of CAN/CSA-A23.1-M90. The Contractor shall, at his own expense, correct such work or replace such materials found to be defective under this specification in an approved manner to the satisfaction of the Engineer.

1.0 GENERAL

1.1 Scope

1.1.1 These specifications cover the requirements for the supply of Portland Cement Concrete to be used for all concrete work unless otherwise specified. The constituent materials - cement, aggregates, water and admixtures shall conform to the requirements of this specification. Where a Standard is referenced in this Specification, the current version of that Standard shall apply.

2.0 PRODUCTS

2.1 Portland Cement

2.1.1 All cement shall be either Type GU Normal Portland Cement or Type HE High Early Strength Portland Cement or Type HS Sulphate Resistant Portland Cement conforming to the requirements of CSA Standard A5.

2.1.2 The Engineer shall be notified within 5 days of any changes to cement supply.

2.1.3 All chemical and physical test results of cement to be used in the production of the ready-mixed concrete shall be supplied to the Engineer.

.1 Certified copies of the test results supplied by the manufacturer of the cement will be sufficient.

2.2 Supplementary Cementing Materials

2.2.1 Use of Type F or CI fly ash, conforming to the requirements of CSA Standard A23.1, is permitted as follows:

.1 Not more than 20% of the mass of the total cement material content may be replaced with fly ash.

.2 Document the percentage of fly ash in the mix design.

.3 No fly ash shall be used after September 15th.

2.2.2 Use of Type N pozzolan, conforming to the requirements of CSA Standard A23.1, is permitted as follows:

.1 Not more than 10% of the mass of the total cement material content may be replaced with pozzolan.

.2 Document the percentage of pozzolan in the mix design.

.3 No pozzolan shall be used after September 15th.

2.2.3 All chemical and physical test results of supplementary cementing material to be used in the production of the ready-mixed concrete shall be supplied to the Engineer.

.1 Certified copies of the test results supplied by the manufacturer of the supplementary cementing material will be sufficient.

.2 One copy of the report shall be submitted within 5 days to the Engineer.

.3 Test data shall be provided to the Engineer within 5 days when using supplementary cementing materials for alkali silicate reactivity (ASR) or sulphate resistance.

2.3 Aggregates

2.3.1 Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1, Section 4.2.3.

2.3.2 The nominal size of coarse aggregates shall be 20 mm as per Section 4.2.3.4, Table 11, Group I

2.3.3 The maximum aggregate size for Low Shrink Material shall be 6 mm.

2.3.4 The maximum allowable shale content in the aggregate shall not exceed one half of one percent.

2.3.5 Representative samples of all aggregates proposed for use shall be submitted, when requested, to the Engineer sufficiently in advance of the commencement of operations to permit carrying out the required tests.

2.3.6 Upon request of the Engineer, the Contractor shall provide the legal land description of the source pits for the aggregates used in this contract.

2.3.7 Upon request of the Engineer, the Contractor at his expense shall provide a Petrographic analysis as per ASTM Standard Practice C295.

2.4 Water

2.4.1 Water shall be clear and free from injurious amounts of oil, acid, alkali, soluble chlorides, organic matter, sediment or any other deleterious substances.

2.4.2 Water shall conform to the requirements of CSA Standard A23.1, Section 4.2.2.

2.5 Admixtures

2.5.1 The admixtures shall conform to the latest requirements of CSA Standard A23.1, Section 4.2.4.

2.5.2 The manufacturer shall ensure that any additives used are compatible with the cement and with each other.

.1	Air-entraining:	Shall conform to the requirement of ASTM Standard C260.
.2	Chemical:	Shall conform to the requirement of ASTM Standard C494.

2.5.3 Other admixtures shall not be used, unless specified herein, without the written approval of the Engineer.

2.6 Storage of Materials

2.6.1 Materials are to be stored and handled in accordance with CSA Standard A23.1 Section 5.

2.7 Strengths and Proportions

2.7.1 The proportions of materials shall be such as to produce a concrete mix which will work readily into the corners and angles of the forms and around the reinforcement.

2.7.2 The manufacturer is to assume responsibility for the design and production of the concrete mixture in accordance with Alternative Number 1, Table 5, and CSA Standard A23.1. Section 4.4.6.7 Compressive Strength Requirements and Section 4.4.6.8 Failure of Standard-cured Cylinder Test Results to Meet Requirements of CSA Standard A23.1 are superseded by the Strength Tests and Understrength Concrete requirements of Section 2500 for the Supply of Portland Cement Concrete.

2.7.3 The concrete mixes shall, in addition to any other provisions of these specifications, conform to the following table:

MIX NO.	NAME AND TYPE OF CEMENT	MINIMUM SPECIFIED 28-DAY COMPRESSIVE STRENGTH	AIR CONTENT	MAXIMUM WATER/ CEMENTING MATERIALS RATIO BY WEIGHT	SPECIFIED SLUMP
	Handformed Concrete				
1	Normal - GU	32 MPa	6.5% ± 1%	0.45	70 mm ± 20 mm
1FH	Fly ash - GU	32 MPa	6.5% ± 1%	0.45	70 mm ± 20 mm
1NP	Natural Pozzolan - GU	32 MPa	6.5% ± 1%	0.45	70 mm ± 20 mm
1HE	High Early Strength	32 MPa	6.5% ± 1%	0.45	70 mm ± 20 mm
1EA	Exposed Aggregate	32 MPa	6.5% ± 1%	0.45	70 mm ± 20 mm
2	Sulphate-Resistant - HS	30 MPa	6.5% ± 1%	0.50	70 mm ± 20 mm
	Extruded Concrete				
3	Normal - GU	32 MPa	6.5% ± 1%	0.45	30 mm ± 10 mm
3FE	Fly ash - GU	32 MPa	6.5% ± 1%	0.45	30 mm ± 10 mm
3NP	Natural Pozzolan – GU	32 MPa	6.5% ± 1%	0.45	30 mm ± 10 mm
	Concrete Base				
4	Normal - GU	15 MPa	6.5% ± 1%	-	100 mm ± 30 mm
4FH	Fly ash - GU	15 MPa	6.5% ± 1%	-	100 mm ± 30 mm
4NP	Natural Pozzolan - GU	15 MPa	6.5% ± 1%	-	100 mm ± 30 mm
4HE	High Early Strength	15 MPa	6.5% ± 1%	-	100 mm ± 30 mm
	Low Shrink Material				
5	Normal - GU	0.25-0.75 MPa	-	-	175 mm ± 30 mm

2.7.4 Mix design shall also include test results from abrasion loss pursuant to test method A23.2-16A and A23.2-17A. The test shall be conducted on both coarse and fine aggregate, not just the fine aggregate pursuant to Table 1.

2.7.5 No concrete shall be placed until the Engineer has received copies of the mix design and has given written approval of its use.

3.0 EXECUTION

3.1 Batch Plants

3.1.1 Concrete is to be produced in accordance with CSA Standard A23.1 (Section 5). Batch plants are subject to certification by the Saskatchewan Ready Mix Concrete Association.

Delivery and Mixing

3.2.1 Concrete shall be delivered in truck mixers.

3.2.2 The concrete shall be delivered to the site of the work and discharge shall be completed within one and one-half hours after the introduction of mixing water to the cement and aggregates, or the introduction of the cement to aggregates.

3.2.3 The allowable concrete temperature at delivery shall be in accordance with CSA A23.1-09 Table 14. The concrete temperature shall be tested in accordance with CSA A23.2-17C.

4.0 ACCEPTANCE

4.1 Inspection

4.1.1 The Engineer shall be afforded proper access to inspect ingredients and processes used in the manufacture and delivery of the concrete and for securing samples to determine whether the concrete is being furnished in accordance with these specifications. All tests and inspections shall be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

4.1.2 Sampling of concrete shall be obtained in accordance with Methods of Test and Standard Practices for Concrete CSA A23.2.

4.2 Strength Tests

4.2.1 For standard and accelerated strength tests either 100 mm X 200 mm or 150 mm X 300 mm cylinders shall be used. The size of the cylinder used shall, however, meet the aggregate size limitations as specified in clause 6.2 of CSA Test Method A23.2-3C.

4.2.2 Test cylinders will be used as the basis of acceptance of the concrete compressive strength. Cylinders for strength tests shall be made in accordance to CSA Test Method A23.2-3C. No field cured cylinders will be used as a basis of acceptance. A strength test for any class of concrete shall consist of two standard cylinders made from a sample secured from a single load of concrete in accordance with CSA Test Method A23.2-1C. A total of three test cylinders are to be cast with one cylinder tested at seven days and two tested at twenty-eight (28) days. The test result shall be the average of two (2) specimens at twenty-eight (28) days except that if one specimen in a test shows a manifest evidence of improper sampling, molding or testing, it shall be disregarded. Contrary to Section 4.4.6.3 of CSA Standard A23.1, frequent testing will be conducted as directed by the Engineer.

4.2.3 The Contractor shall apprise himself of the testing procedures used by the Engineer. In the case of discrepancy between the test results of the Contractor and the Engineer, the Engineer's results shall be final.

4.2.4 Coring and testing of defective concrete shall be considered to be representative of twenty-eight day lab cured cylinder results, only if the following criteria are met:

.1 Coring and testing shall be at the expense of the Contractor.
.2 Concrete was placed after April 15 and before September 15.
.3 Concrete is cored, tested and reported within 35 days of concrete placement.
.4 Drilled cores shall be sampled and tested in accordance with CSA A23.2-14C.
.5 Core results shall be reported as per CSA Clause 4.4.6.7.2.

4.3 Air Content

4.3.1 Air content tests shall be determined in accordance with the most recent edition of CSA Standard A23.1 (Test Method A23.2-7C or A23.2-4C).

4.3.2 The following criteria apply to all mixes numbered 1, 2 and 3. The concrete load shall be rejected if the air content measured is less than 4.4%. If air content is measured between 4.4% and 5.4% the supplier will be allowed to add air to bring it within specification. In this latter event, however, if the initial air content measured in three consecutive loads of concrete delivered falls below 5.4%, the third load shall be rejected and all subsequent loads shall be rejected until initial air content measured is again over 5.4%.

4.3.3 If measured air content exceeds the limit of the specification the supplier may elect to turn the drum. If this action brings the load within the specification before the time limit for age of concrete expires, the concrete may be accepted at the discretion of the Engineer.

4.3.4 Any additional costs due to extra testing will be at the Contractor's expense.

4.3.5 If concrete placed is not within specification, the Engineer may request linear traverse testing as per ASTM standard C457 at the Contractor's expense.

4.3.6 Air Content Payment Adjustment Factors

.1

Air Content	Payment
3.5% - 4.4%	25%
4.5% - 5.4%	75%
5.5% - 7.5%	100%
7.6% - 9.0%	100% pending approval of the 28 day compressive

	strength results
< 3.5% or > 9.0%	Concrete must be removed and replaced at the expense of the Contractor

.2 Penalties will be assessed when the specified air content is not met. Payment reduction will be assessed on the total quantity of the day (cubic metres).

4.4 Slump Test

4.4.1 Concrete delivered to the site which exceeds the maximum specified slump shall be rejected. When concrete delivered to the site is less than the specified range of slump additional water, or chemical admixture may only be injected into the mixture at the discretion of the Engineer. The drum shall be turned until the uniformity of the concrete is within the allowable limits.

4.5 Understrength Concrete

4.5.1 These requirements shall not apply to field-cured specimens.

4.5.2 The strength level of each class of concrete shall be considered satisfactory, if it is equal to or exceeds the specified 28 day strength.

4.5.3 The following remedies shall be applied only when the above criteria are not met. Notwithstanding the options of the Owner set forth in Section 4.4.6.8, Failure of Tests to Meet Requirements of CSA Standard A23.1, the Owner reserves the right, in the Owner's sole discretion, to accept such concrete installed at the place of Work, with or without conditions, and to reduce payment on individual strength tests for that day's production not meeting the minimum strength tests for that class at one age, in accordance with the following:

.1 For Mixes No. 1, No. 1FH, No. 1HE, No. 1EA, No. 3, and No. 3FE, concrete represented by concrete cylinder tests between 24 MPa and 32 MPa will be subject to payment reduction per cubic metre and concrete represented by concrete cylinder tests below 24 MPa shall be rejected and replaced at the expense of the contractor.

.2 For Mix No. 2, concrete represented by concrete cylinder tests between 22.5 MPa and 30 MPa will be subject to payment reduction per cubic metre, and concrete represented by concrete cylinder tests below 22.5 MPa shall be rejected and replaced at the expense of the contractor.

.3 For Mixes No. 4 and 4HE, concrete represented by concrete cylinder tests between 12 MPa and 15 MPa will be subject to payment reduction per cubic metre, and concrete represented by concrete cylinder tests below 12 MPa shall be rejected and replaced at the expense of the contractor.

.4 Reduction in payment described in (.1), (.2) and (.3) above shall be calculated as follows:

.1 Reduction in Payment

$$= \frac{\text{Specified Strength - Actual Strength}}{\text{Specified Strength}} \times 4.0$$

multiplied by the price per cubic metre and the volume supplied for that day.

.2 Costs of replacement of rejected concrete shall include removal of the rejected concrete and replacement thereof and all labour, equipment and material costs, including applicable overhead, associated therewith.

.3 No bonus shall be paid for supply of concrete that exceeds the minimum specified strength.

.4 Penalties will be assessed when the minimum specified strength is not met. Payment reduction will be assessed on the total quantity of the day (cubic metres).

1.0 GENERAL

1.1 Scope

1.1.1 Concrete sidewalk, sidewalk crossing, curb and gutter, rolled curb and gutter, monolithic walk, curb and gutter, concrete apron and structural sidewalk shall be constructed in accordance with the following specification and the standard drawings. The type of construction to be used will be shown on the construction plans or as directed by the Engineer and shall be in accordance with the provisions of this section.

1.1.2 The Contractor will be given the option of constructing hand formed sidewalk, curb and gutter at the unit rate bid in the schedule, provided that tie bars are used to tie the walk to the curb and gutter when poured separately. Extruded concrete shall meet the requirements of these specifications.

2.0 PRODUCTS

2.1 Concrete

2.1.1 Concrete shall conform to Section 2500.

2.2 Granular Material

2.2.1 Granular Material shall conform to:

SIEVE DESIGNATION	PERCENT PASSING BY WEIGHT
20 mm	100
12.5 mm	75 - 100
5 mm	50 - 100
400 μm	10 - 45
80 μm	0 - 10
Plasticity Index	0 - 6

2.3 Curing Compound

2.3.1 The Compound shall equal or exceed the A.S.T.M. "Specification for Liquid Membrane-Forming Compounds for Curing Concrete," Designation C-309. The water retention efficiency tests shall be carried out in accordance with A.S.T.M. Designation C-156.

2.3.2 The Compound shall adhere to damp concrete having a horizontal or vertical surface and form a continuous film when applied according to the manufacturer's instructions. When dried, the Compound shall not be tacky

and must adhere to the concrete surface even under normal pedestrian traffic conditions. The film shall not render the concrete surface slippery. The Compound shall be clear or translucent, resinous base, non-bituminous. It shall contain a fugitive dye, readily distinguishable upon the concrete for at least four hours after application. The colour shall become inconspicuous within seven (7) days of application.

3.0 EXECUTION

3.1 Excavation and Base

3.1.1 The subgrade shall be excavated in accordance with Section 2110, Section 2120, Section 2130, and/or Section 2140.

3.1.2 Disturbed subgrade material shall be compacted to a minimum of 95 % of standard proctor density. Density tests shall be done as deemed necessary by the Engineer.

3.1.3 A 150 mm layer of granular sub-base or basebedding shall be used as a levelling material under concrete sidewalks, curb and gutters unless the curb is to be constructed on granular base course. If necessary, granular base course or native earth material (in accordance with their respective specifications) shall be used to raise the subgrade to allow for the 150 mm layer of sub-base or base. Recycled material meeting the specifications for sub-base or base may be substituted, if approved by the Engineer. The requirement for a 150 mm layer of levelling material may be waived if automatic fine-grading equipment is approved in writing by the Engineer or if the levelling course is greater than 150 mm then a granular base course can be used. Automatic grade and line control will be required for the fine-grading equipment.

3.1.4 The base on which the concrete will rest shall be compacted to a minimum 95% standard proctor density. Density tests of the base shall be done as deemed necessary by the Engineer.

3.1.5 If the base on which the concrete will rest is dry, it shall be thoroughly wetted immediately prior to placing the concrete.

3.1.6 Concrete shall not be placed on frozen, wet, soft base or subgrade material unless used as a temporary measure until it can be removed and properly placed and approved by the Engineer.

3.2 Forms

3.2.1 Forms shall be in accordance with CSA 7.2.4.7 and be of steel or wood of sufficient strength to resist the pressure of plastic concrete, and the supply shall be sufficient to permit their remaining in place not less than twelve

(12) hours after concrete has been placed, or longer if the Engineer considers it necessary, unless the surface of the concrete is to be finished. The use of bent, twisted, battered or worn-out forms will not be permitted. Forms may be checked for alignment and elevation by the Engineer before concrete is poured, and shall be cleaned and oiled before each use. Where required, reinforcement shall be secured in the location shown on the drawings and shall be free from scale, grease and rust immediately prior to placing concrete. Forms shall be held securely by approved methods to prevent movement and bulging when the concrete is being placed. Forms must be approved by the Engineer before concrete is poured. Flexible forms will be required for all curves with a radius of less than 5 m.

3.3 Depositing of Concrete

3.3.1 All concrete placing methods shall be subject to the approval of the Engineer. Concrete placing shall not be started until the Engineer has inspected and approved all preparations including forms, bedding, reinforcing steel, construction joints, and all mixing conveying, spreading, compacting, finishing, curing and protection equipment. Concrete shall be conveyed from the mixer to the point of deposit as practicable, using means and equipment which will prevent separation or loss of materials.

3.3.2 Concrete shall be deposited in the forms as close as practicable to its final position, and in no case more than l m from the point of final deposit in the horizontal or vertical direction.

3.3.3 Special care shall be taken to place the concrete against the forms, particularly in corners, in order to prevent voids, pockets, rough areas and honeycombing. The concrete shall be tamped in such a manner as to work the coarse aggregate away from the forms and exposed surfaces. Vibrators or vibrator speeds used in placing concrete shall be a minimum of 5,000 cycles per minute. Concrete shall be placed continuously until a complete section between expansion joints has been poured.

3.3.4 The concrete shall be thoroughly consolidated against and along the faces of the forms. Hand spreading shall be done with shovels and concrete rakes, in order that the concrete will not be segregated. Precautions should be taken to prevent overworking of the concrete.

3.4 Finishing

3.4.1 The surface shall be levelled in accordance with CSA A23.1-04. A vibrator mounted levelling beam or other appropriate equipment may be used if approved by the Engineer. Special care shall be taken not to over-vibrate the concrete and in no case shall an excess of water be brought to the surface/or added to the surface. The surface shall then be

marked in the specified manner and left until the concrete has set sufficiently to permit the finishing operations without causing bleeding. At this time the surface shall be brought to a true surface with a wood-float and a uniform brush finish shall be applied. Final marking of the blocks shall then be carried out leaving blocks with edges rounded or levelled to a radius of not less than 10 mm. The edges of the walk and the lines dividing the walk into sections shall be rigidly straight; joints with ragged edges will not be permitted.

3.4.2 The Contractor shall mark each City block or portion of block with a suitable tool showing the name of the Contractor and the year constructed.

3.4.3 The Contractor shall supply the marking tool and shall mark the sidewalk with the letters "WCB" at each water curb box location. The mark is to be placed 150 mm from the back of the sidewalk.

3.5 Joints

3.5.1 Expansion Joints

.1 Expansion joints are required where specified. This joint shall be 10 mm wide and truly perpendicular. The expansion joint material shall be supplied by the Contractor and approved by the Engineer and shall meet the requirements of A.S.T.M. Designation D1751 or D1752.

.2 No expansion joints shall be placed within 3 m of a service connection lead, catch basin or fire hydrants.

.3 A strip of expansion joint material 10 mm thick and to the full depth of the sidewalk shall be placed around the base of all poles and other isolated places as specified.

3.5.2 Contraction Joints

.1 Contraction joints shall be placed every 1.5 m or less, by means of a marking tool or other approved method, whose depth shall not be less than 40 mm and width shall not be less than 3 mm. The edge of the joint shall be rounded off with an edger having an arc of a circle having 10 mm as a radius. These joints shall be perpendicular to the longitudinal axis of the sidewalk, curb and gutter and shall extend through the full width of the sidewalk, curb and gutter.

3.5.3 Surface Joints

.1 After trowelling, a joint not less than 10 mm deep shall be marked

in the surface of the walk as shown on the drawings. The edge of the joint shall be rounded off with an edger having an arc of a circle of a 10 mm radius.

3.5.4 Sawed Joints

.1 If required, saw joints shall be made with a special concrete saw capable of producing a true straight joint of constant depth in accordance with Section 2010.

3.5.5 Cold Joints

.1 Cold joints are required at the end of each day's placement of concrete at a contraction joint location. This joint shall be perpendicular to the surface and curb line. Dowels are to be inserted, as shown on the standard drawings, in order to provide a tie to the next pour of concrete.

3.6 Reinforcing

3.6.1 The radii shall have five, 10 M reinforcing bars for monolithic walk curb and gutter in accordance with the pattern shown in Standard Roadway Drawing R-9A. In residential areas, reinforcing in the curb radius may be omitted if approved by the Engineer. Use reinforcing bar, to bond new to older work at cold joints, in accordance with the pattern shown in Standard Roadway Drawing R-7B – Dowel Detail for Expansion Joints. At least 150 mm of the dowels shall extend beyond the cold joint, into existing concrete.

3.6.2 All separate curb and gutter constructed adjacent to Commercial or Industrial Zoned Areas shall be reinforced with two 10 M reinforcing bars.

3.6.3 All curb and gutter and sidewalk bridging a catch basin, manhole or similar underground support shall be reinforced in accordance with the pattern shown in Standard Roadway Drawings R-11 (A, B, C). At least 150 mm of the dowels shall extend beyond the cold joint, into existing concrete.

3.6.4 All walk poured as a separate operation behind the curb and gutter shall be held in place by 600 mm 10 M bars inserted into the curb and gutter, at 1.5 m on centre (centre line of walk panels). At least 150 mm of the bar shall extend beyond the cold joint, into existing concrete.

3.6.5 All Commercial and Industrial crossings shall be reinforced in accordance with the pattern shown in Standard Roadway Drawing R-10. At least 150 mm of the dowels shall extend beyond the cold joint, into existing concrete.

3.7 Curing and Protection

3.7.1 After the concrete has been finished to cross-section and as soon as the concrete has set sufficiently, the entire surface shall be sprayed with a concrete curing compound in a manner and in such quantity as will be directed by the Engineer. All concrete surfaces that are left exposed to the air after removal of forms shall be cured in the same manner as described in the immediately above after removal of forms.

3.7.2 No vehicular traffic shall be allowed to cross the crossings for a period of seven (7) days after construction or when 20 MPa has been reached (field cure cylinders or concrete cores) and substantial barricades shall be erected and maintained for this purpose. All freshly laid concrete shall be barricaded with suitable barricades for a period of one (1) day and any damage to the finish of the walks or crossings shall be corrected.

3.7.3 No heavy construction equipment shall be allowed to operate adjacent to the freshly laid concrete for a period of seven (7) days for normal strength concrete and three (3) days for high early strength concrete or when 20 MPa has been reached (field cure cylinders or concrete cores)or as approved by the Engineer.

3.7.4 If these corrections are not carried out before the concrete is hardened, repairs shall be made by the Contractor by replacing all damaged walk or curb and gutter. Patching will not be permitted. The forms shall be removed with care, as not to damage the walk or curb. In the event of any defect in construction or finish, the entire sections must be removed on the order of the Engineer.

3.7.5 The Contractor shall maintain on the job sufficient canvas or other suitable covering to protect all freshly laid concrete from the action of the elements.

3.8 Cold Weather Requirements

3.8.1 When the atmosphere has a temperature lower than 5 ^{o}C, all reinforcing materials, forms, and ground with which the concrete is to come in contact shall be defrosted and in no case shall concrete be deposited on or against any surface which is at a temperature of less than 2 ^{o}C.

3.8.2 No concrete shall be placed on frozen subgrade (native or granular). If the subgrade is frozen it shall be thawed prior to concrete placement.

3.8.3 Concrete placement and protection shall be limited by the following table. Concrete temperature shall not drop below 10 ^{o}C during the curing period.

Rapid cooling of the concrete at the end of the heating period is to be avoided.

OUTSIDE MINIMUM AMBIENT AIR TEMPERATURE	PROTECTIVE MEASURES
5 ^{o}C to 25 ^{o}C	Normal curing - no temperature protection required.
Below 5 ^{o}C	Adequate insulation for 7 days to achieve strength specified in CAN/CSA3-A23.04 with suitable enclosure or supplementary heat.

3.8.4 The Contractor may request the use of high early strength concrete at his own expense.

3.8.5 All concrete showing evidence of freezing shall be removed from the job and replaced at the Contractor's expense.

3.9 Hot Weather Requirements

3.9.1 Hot weather is defined for the purpose of this specification as a combination of low relative humidity, windy conditions and high temperatures. The Contractor is advised that the placing of concrete when the evaporation rate exceeds 0.5 kg/m^2/hr (determined from Standard Drawing R-18) results in a substandard product that shall not be accepted. The removal and replacement of such if required would be at the Contractor's expense.

3.9.2 The Contractor shall limit the amount of concrete poured during hot weather to enable the work to be finished to the satisfaction of the Engineer. Surface wetting to facilitate finishing is not permitted. Protective measures to prevent fast setting of the concrete are to be implemented.

3.10 Inspection

3.10.1 The finished surfaces of all concrete work shall be true to the required cross-section with a tolerance of ± 10 mm from the required elevation and dimensions. Surfaces of curbs, gutters or sidewalks shall not show any depressions or bumps exceeding 5 mm under a straight edge 3 m long, placed parallel to the curb or sidewalk. Concrete not meeting the requirements specified shall be removed to the nearest joint and replaced at the Contractor's expense.

3.11 Walk Transition

3.11.1 At those corners where the sidewalk width is reduced from 1.5 m to 1.2 m the reduction should be tapered uniformly throughout the entire curve.

3.12 Driveway Crossings

3.12.1 The depth of the walk shall be increased from 130 mm to 180 mm for any crossings in or adjacent to commercial and/or industrial zone properties. Reinforcing for Commercial and Industrial crossings shall be in accordance with Roadway Standard Drawing R-7A. The payment for the extra 50 mm of concrete required for such crossings shall be included in the tender price for concrete crossing. Reinforcing bar may be required in certain crossings as designated in this Section, on the plans, City of Regina Standard Drawings or by the Engineer.

	DEPTH
Residential	130 mm
Alley	180 mm (see R-7A for reinforcing)
Commercial	180 mm (see R-7A for reinforcing)
Industrial	180 mm (see R-7A for reinforcing)

3.13 Pedestrian Ramps

3.13.1 Pedestrian ramps shall be installed in all radii according to details set out in City of Regina Standard Drawing R9-A or as approved by the Engineer. Tactile Markings shall be produced by a tool similar in detail to that set out in City of Regina Standard Drawing R-9B.

3.14 Completion Inspection Criteria

3.14.1 The acceptance criteria for Concrete shall conform to sections 2500 and 2550 of the specifications.

3.14.2 The finished Concrete shall be free of but not limited to cracking (horizontal, longitudinal, shrinkage, craze, and settlement), scaling, chipping, pop-outs (caused by deleterious material, lightweight shale and chert and ironstone), blisters, honeycombing, rain spots, marring from plastic covering, staining, drainage defects, and Alkali Silicate Reactions. Either a pay reduction or a remove and replace will be applied based on the criteria in the following table:

Deficiency Item	**Action Required**	**Corresponding Pay Reduction**
Cracking	Length and width of cracking measured • Penalty applied, or • Remove and replace panels affected	50% pay reduction for affected area based on severity.
Scaling	Remove and replace panels affected	
Chipping	Remove and replace panels affected	
Pop-outs	Area measured. Number of pop-outs counted for the area. • Penalty applied, or • Remove and replace panels affected if 3 or more per panel	50% pay reduction for affected area.
Blisters	Remove and replace panels affected.	
Honeycombing	• Repair as directed by Engineer, or • Remove and replace	
Rain spots	Area measured. • Penalty applied, or • Remove and replace panels affected	50% pay reduction for affected area based on severity.
Marring from plastic	Area measured. • Penalty applied, or • Remove and replace panels affected	50% pay reduction for affected area based on severity.
Staining	Area measured. • Penalty applied, or • Remove and replace panels affected	50% pay reduction for affected area based on severity.
Footprints, tire tracks, graffiti, etc.	Area measured. • Remove and replace panels affected based on severity	

Deficiency Item	**Action Required**	**Corresponding Pay Reduction**
Drainage defects	Remove and replace panels affected.	
Alkali Silicate Reaction defects	Remove and replace panels affected	

3.14.3 When a deficiency is removed and repaired, the size of section is to be determined by the Engineer. The new material will be subject to testing and inspection of the product for conformance to this specification.

3.14.4 The action required in the previous table will be determined by the Engineer. If applicable the Engineer may allow the Contractor options as presented in the previous table.

1.0 GENERAL

1.1 Scope

1.1.1 The work shall consist of paving the centre median area between the concrete boulevard curbs with 150 mm of selected granular material and 100 mm of Portland Cement concrete.

2.0 PRODUCTS

2.1 Concrete

2.1.1 Concrete shall conform to Section 2500 and Section 2550.

2.2 Granular Material

2.2.1 Granular material shall conform to:

SIEVE DESIGNATION	PERCENT PASSING BY WEIGHT
20 mm	100
12.5 mm	75 - 100
5 mm	50 - 100
400 μm	10 - 45
80 μm	0 - 10
Plasticity Index	0 - 6

3.0 EXECUTION

3.1 Construction

3.1.1 The subgrade shall be excavated in accordance with Section 2110, Section 2120, Section 2130, and/or Section 2140.

3.1.2 A 150 mm layer of clean gravel or sand bedding shall be used as a levelling material under concrete median, boulevard & island paving unless it is to be constructed on granular base course. If necessary, granular base course or native earth material (in accordance with their respective specifications) shall be used to raise the subgrade to allow for the 150 mm layer of clean gravel or bedding sand.

3.1.3 The base on which the concrete will rest shall be spread, tamped and thoroughly wetted immediately prior to placing the concrete. The base must not be frozen.

3.1.4 The Portland Cement concrete median paving shall be constructed in accordance with the plan for median strip paving.

1.0 GENERAL

1.1 Scope

1.1.1 The work shall consist of levelling and preparing the seed bed, seeding, fertilizing and cleaning up areas to be seeded in coarse grass as shown on the plan on as designated by the Engineer.

2.0 PRODUCTS

2.1 Grass Seed Mixtures

2.1.1 Use a grass seed mixture equivalent to the one growing on site or a mixture of:

.1 40% Canada Certified No. 1 Canada Bluegrass ('Reubens')

.2 20% Canada Certified No. 1 Hard Fescue ('Aurora', 'Serra', 'Spartan')

.3 15% Canada Certified No. 1 Chewings Fescue ('Jamestown', 'Victory')

.4 15% Canada Certified No. 1 Creeping Red Fescue ('Boreal', 'Jasper', 'Dawson')

.5 10% Common No. 1 Perennial Rye Grass

NOTE: Acceptable cultivars include, but are not limited to, those listed in parentheses. Substitutions for any of the above must be approved by the Engineer.

2.1.2 An alternate mixture may be substituted, with the permission of the Engineer, in areas where regular maintenance is doubtful. The mixture will contain:

.1 25% Smooth Brome ('Carlton')

.2 25% Streambank Wheatgrass ('Sodar')

.3 25% Russian Wild Rye ('Swift')

.4 25% Alfalfa ('Heinrichs')

NOTE: Acceptable cultivars include, but are not limited to, those listed in parentheses. Substitutions for any of the above must be approved by the Engineer.

2.1.3 All seed specified as Canada Certified No. 1 Grade or Common No. 1 Grade shall be as per Government of Canada Seeds Act Grade Standards.

2.1.4 All seed must be obtained from a recognized seed house or supplier.

2.2 Fertilizer

2.2.1 Fertilizer shall be 16-32-6 controlled release, sulphur coated urea (SCU) or ammonia sulphate fertilizer.

2.3 Fill Soil

2.3.1 Shall be clean material free of sands, gravels, concrete, asphaltic concrete and other debris.

3.0 EXECUTION

3.1 Construction

3.1.1 Where designated on plans, ground surface shall be worked by equipment in order to fill in low spots and reduce high spots in such a manner as to promote drainage.

3.1.2 Unsuitable and excavated material shall be disposed of by the Contractor at a site designated by the Engineer.

3.1.3 Landfill costs shall be the responsibility of the Contractor.

3.1.4 Where specified on plans or designated by the Engineer, the Contractor shall distribute and level fill soil to a depth of seventy-five millimetres (75 mm).

3.1.5 Ground surface shall be disced to a minimum depth of seventy-five millimetres (75 mm) to prepare seedbed.

3.1.6 Discing shall be followed by harrowing to level out the ground surface.

3.1.7 Should the seeding be done with a large brillion or other applicable type of seeder the work would be acceptable.

3.1.8 Seeding shall follow harrowing, the seed (mixture as specified) to be spread on ground surface at a rate of 2.5 kg per 100 m^2.

3.1.9 Fertilizer shall be spread at a rate of 2.5 kg per 100 m^2 or as recommended by soils test.

3.1.10 After seed and fertilizer have been applied, ground surface shall be harrowed a second time to cover the mixture.

3.1.11 Clean up immediately, soil or other debris spilled onto pavement and dispose of deleterious materials.

1.0 GENERAL

1.1 Scope

1.1.1 The work will consist of installing corrugated steel pipe culverts at locations and in conformity with lines, grades and cross-sections shown on the plans or designated by the Engineer.

2.0 PRODUCTS

2.1 CSP Pipe

2.1.1 Shall be galvanized with bituminous exterior and interior protective coating. Corrugated Steel Pipe shall conform to the requirements of CSA G401-01. Thickness and size shall be as shown on the plans or as designated by the Engineer.

2.2 Granular Material

2.2.1 Shall be clean sand free from injurious amounts of deleterious substances. Ninety-five percent (95%) shall pass a 10 mm sieve and no more than five percent (5%) shall pass a 160 μm sieve.

2.3 Rip Rap

2.3.1 Shall be hard, dense, durable field stone, boulders, quarry rock or broken concrete well graded in size between 150 and 300 mm with a minimum of 50% by weight exceeding 200 mm in diameter.

2.4 Geotextile

2.4.1 Employ medium weight non-woven geotextile Propex 4553 or prior approved equivalent when and where specified for rip rap.

3.0 EXECUTION

3.1 Construction

3.1.1 The excavation for the culvert and the culvert bed, including sub-cut if required, shall be in accordance with Sections 2110 and 2130. If the foundation is unsuitable, the bottom of the bed shall be sub-cut to the dimensions staked by the Engineer. The sub-cut shall be backfilled in accordance with the requirements for embankments as designated by the Engineer. The bedding line shall be shaped to fit the culvert.

3.1.2 Corrugated steel pipe culverts shall be placed with the inside circumferential laps pointing downgrade and with the longitudinal laps at the sides or quarter points. The sections of the culvert shall be firmly joined with coupling bands. Joints shall be as tight as possible.

3.1.3 Granular backfill under the haunches of culverts shall be compacted with mechanical impact tampers. If a density for embankments has not been specified, mechanical impact tampers shall be used for compacting the earth material against the culvert.

3.1.4 After the earth backfill and granular backfill has been placed and compacted around the culvert, the remainder of the embankment shall be constructed in accordance with the requirements for Embankments. The earth material above the bedding line shall be placed, simultaneously and uniformly, in lifts on each side of the culvert. In sub-cut, the lift shall extend to the limits of the sub-cut; otherwise the lifts shall extend not less than 15 m from each side of the culvert.

3.1.5 No objectionable material shall be used within that portion of the embankment above or below the bedding line on culverts through the roadbed. The embankment, within three (3) diameters or three (3) spans of the culvert barrel, shall be free from rocks having a dimension of 75 mm or greater when measured in any direction.

3.1.6 Rip rap quantities and placement for erosion control culverts shall conform to Standard Sewer Drawing S-23. The material referred to as rip rap shall consist of hard, dense, durable field stone, boulders, quarry rock or broken concrete, well graded in size between 150 mm and 250 mm with a minimum of 50% by weight exceeding 200 mm in diameter.

3.1.7 The Contractor shall repair or replace, at no direct expense to the City of Regina, any culvert damaged by his operation.

1.0 GENERAL

1.1 Scope

1.1.1 The work shall consist of supply and installing chain link fence, including braces and gates constructed in accordance with the plans and specifications and at locations designated by the Engineer.

1.1.2 All fence construction shall take place from the road right-of-way side of the property line. The Contractor may enter private property only after obtaining written permission from the property owner.

2.0 PRODUCTS

2.1 Quality

2.1.1 All fencing materials including concrete shall be new and supplied by the Contractor. All fencing material shall be Frost Fence, chain link fence, or equal.

2.2 Fence Fabric

2.2.1 The chain link fence fabric shall be 50 mm mesh by 9 gauge, zinc coated after weaving. Minimum zinc coating to be 490 grams per square metre of surface area. The fabric height shall be 1,830 mm except where 1,200 mm fence is specified.

2.3 Line Posts

2.3.1 The line posts shall be 60 mm O.D. with minimum weight of 5.43 kg per metre, Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre. The minimum length of line posts shall be 2,670 mm except where 1,200 mm fence is specified.

2.4 Terminal Posts and Straining Post

2.4.1 The terminal posts and straining posts shall be 90 mm O.D. with minimum weight of 11.24 kg per metre, Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre. The minimum length of terminal posts and straining posts shall be 2,900 mm.

2.5 Top Rails and Pipe Braces

2.5.1 The top rails and pipe braces shall be 43 mm O.D., Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre. TOP RAILS ARE NOT TO BE USED IN TRAFFIC AREAS. A 6 gauge top

cable shall be used in its place.

2.6 Top and Bottom Wire

2.6.1 Wire shall be Number 6 Gauge, single strand 57 grams electro-galvanized and be stretched taut along the top and bottom of the fabric fastened at 460 mm intervals.

2.7 Gate Frames

2.7.1 Gate frames are to be made of 43 mm O.D., Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre. All joints to be electrically welded. Gates are to be supplied complete with zinc coated malleable iron hinges, latch and latch catch. Double gates to have centre rest with drop bolt for closed position and chain hold open. Gate latches are to be suitable for padlock which can be attached and operated from either side of gate. Hinges are to permit gate to swing back 180 degrees against fence. Gate braces shall be 33 mm O.D. zinc coated steel pipe with minimum coating of 490 grams per square metre.

2.8 Other Appurtenances

2.8.1 All other appurtenances such as tension bars, bands, rail ends, terminal post tops, line post tops, top rail sleeves, wire ties, nuts, bolts, washers, et cetera, shall be made of zinc coated steel with a minimum coating of 490 grams per square metre.

2.9 Concrete

2.9.1 The concrete used for the base of all posts shall conform to Section 2500.

3.0 EXECUTION

3.1 Construction

3.1.1 Line posts shall be embedded into the centre of a concrete filled hole which measures 300 mm diameter and 1,070 mm deep. The line posts shall be placed at intervals of 3 m centre to centre and shall be set plumb and in accordance with the alignment staked.

3.1.2 Terminal posts and straining posts shall be embedded 1,080 mm into the centre of a concrete filled hole which measures 300 mm in diameter and 1,220 mm deep. The terminal posts and straining posts shall be set plumb and in accordance with the alignment staked.

3.1.3 Straining posts shall be installed as per the manufacturer's instructions or as designated by the Engineer. The maximum spacing of straining posts

shall be 150 m or as designated by the Engineer.

3.1.4 Terminal sections, straining sections and corner sections shall be braced with a pipe brace as per the manufacturer's instructions and as shown in the detailed plans and specifications.

3.1.5 The fence fabric, wire ties, top rail, pipe braces, tension bar and fittings shall be attached to the posts and assembled according to the manufacturer's instructions and as specified on the plans as designated by the Engineer.

3.1.6 The chain link fence shall be attached to the side of the posts facing the private side of the property line. All gates to open inward towards the roadway.

3.1.7 The Contractor shall repair or replace, at no direct expense to the Owner, any fence material damaged by the Contractor's operations.