

## 1.0 CONCRETE-GENERAL

### 1.1 WORK INCLUDED

This section refers to extruded concrete pavements, sidewalks, curbs and gutters and other related work constructed through the use of slip form machines (extruders).

### 1.2 REFERENCE DOCUMENTS

- .1 Perform slip form concrete work in accordance with the following standards except where specified otherwise.
- .2 Concrete Materials and Methods of Concrete Construction—CAN/CSA-A23.1-M90.
- .3 Billet Steel Bars for Concrete Reinforcement - CSA Standard G30.12M.
- .4 American Society for Testing and Materials (ASTM), where noted.
- .5 American Concrete Institute (ACI), where applicable.

### 1.3 RELATED WORK

- .1 Section 05010 – Sub-grade Preparation, Streets
- .2 Section 05020 - Granular Base Preparation, Streets
- .3 Section 05210 - Sidewalk Construction, Streets

## 2.0 MATERIALS

### 2.1 GENERAL

- .1 All materials shall be handled and stored using good practices and in a careful manner, to the satisfaction of the Engineer. Storage of materials shall be in accordance with the requirements of CAN3-A23.1-M90, Section 9, Storage of Materials, except as otherwise specified.

### 2.2 TESTING AND APPROVAL

- .1 At the discretion of the Engineer, all materials supplied under this specification shall be subject to inspection, testing and approval by the Engineer or by the Engineer's designated testing laboratory. If, in the opinion of the Engineer, such materials, in whole or in part, do not conform to the City of Lethbridge Specifications, 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.

### 2.3 CONCRETE MATERIALS

- .1 Portland Cement to CAN/CSA A5-M88. Submit cement manufacturer's mill test reports monthly or as requested by the Engineer.
  - .1 Type 10 -Normal
  - .2 Type 30 - High Early Strength
  - .3 Type 50 - Sulphate Resistant
- .2 Aggregates to Clause 5 of CAN/CSA-A2 3. 1 -M90.
- .3 Water to Clause 4 of CAN/CSA 3-A23.1 -M90, clear from injurious amounts of oil, acid, organic matter, sediment, or other substance harmful to mixing and curing of concrete.
- .4 Air entraining admixture to CAN 3-A266.1 M78.
- .5 Chemical admixtures to CAN 3-A266.2.-M78, including water reducing agents, retarders and accelerators. Do not use retarders and accelerators unless permitted in writing by the Engineer.
- .6 Concrete mix shall satisfy the requirements of Exposure Classification C-2 of Table 8, CAN/CSA A23.1-M90, and shall be In accordance with the following requirements unless shown otherwise on the drawings:
  - 28 day compressive strength - 30 MPa
  - Maximum nominal size of course aggregate - 25 mm
  - Maximum slump - 50 mm
  - Air Content - 5% to 7%
  - Maximum water/cementing materials ratio - 0.45

### 2.4 ACCESSORIES

- .1 Curing compound to ASTM C309, Type 2, Class B, white pigmented, resin based, liquid membrane forming compound.
- .2 Sheet material for curing concrete to ASTM C171.
- .3 Joint sealant to ASTM D1190, hot-poured elastic type.
- .4 Performed joint filler to ASTM D1751.

## 2.5 REINFORCEMENT

1. Reinforcing bars, tie bars to CSA G30.12-M 1 977 Grade 300, billet-steel, deformed bars, uncoated.
- .2 Steel dowels to CSA G 30.1 2-M 1977, clean, plain, free from flattened or burred ends, free from rust, scale or other substances that prevent the bonding of the concrete to the reinforcement, uncoated.
- .3 All epoxy coated steel bars, dowels, wire and wire fabric to ASTM D3963.

## 3.0 EQUIPMENT

### 3.1 GENERAL

- .1 All equipment necessary for the proper handling of materials, batching, mixing, placing, finishing and curing of concrete pavement shall be on the project in good working condition. Throughout the construction of the project, the Contractor shall maintain sufficient, adequate equipment in good, clean, working condition, to assure the proper execution of the work.

### 3.2 MIXING EQUIPMENT

- .1 Concrete may be mixed at the site of construction, at a central point, or wholly or in part in truck mixers. Each mixer shall be an approved type and shall have attached, prominently, a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

### 3.3 SUB-GRADE TRIMMERS

- .1 Trimmers shall be self powered, capable of producing a clean smooth surface true to line and grade as indicated on the Drawings. Remaining loose material on sub-grade shall not exceed 6 mm.

### 3.4 SLIP FORM PAVING MACHINES

- .1 Slip form paving machines, used for concrete placement, shall be of a size and type adequate to handle the width and thickness of the concrete section to be constructed. The slip form paver shall distribute the fresh concrete evenly to the required grade without segregation and without disturbing in-place 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 section and shall be of sufficient length that the concrete will not deform at the edges by the time the forms have passed.

### **3.5 ADDITIONAL EQUIPMENT**

- .1 The Contractor shall furnish all other tools and supplies necessary for the proper execution of the Work.

## **4.0 EXECUTION**

### **4.1 GENERAL**

- .1 Notify the Engineer and the designated testing and inspection firm 24 hours prior to commencement operations.
- .2 Before placing concrete, all equipment for mixing and transporting the concrete shall be cleaned of hardened concrete and foreign material.

### **4.2 SUB-GRADE, SUB-BASE AND BASE COURSE CONSTRUCTION**

- .1 All work shall be performed in accordance with the requirements specified In Sections 05210 for sidewalks, or Section 05020 for pavements.
- .2 No concrete work shall commence until the construction of sub-grade, sub-base and base course has been completed in accordance with the specifications and drawings, and has been approved by the Engineer. Once completed, the surface receiving concrete shall be maintained In a smooth and compacted condition until concrete has been placed. The placing of concrete on a surface 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 shall be free of softened material and ponded water.
- .3 Mixer, ready-mix trucks or other equipment shall not operate in the paving lane unless conditions of the job do not permit operation from outside the lane. If rutting or displacement of the sub-grade material develop, lighter equipment shall be used or suitable supports will be provided. The

Contractor shall correct any rutting or other objectionable irregularities that may have been caused in the paving lane by whatever reasons.

### **4.3 TRANSPORTING CONCRETE**

- .1 The concrete mixing, delivering and spreading operations shall be coordinated as to provide a uniform rate of progress, either fixed-form or slip-form. Stopping and starting of paving equipment shall be held to a minimum.

- .2 Concrete mixed at a central mixing plant shall be transported to the paving site in approved truck mixers, truck agitators or non-agitating trucks. When non-agitating trucks are used to haul concrete, no more than 30 minutes shall elapse from the time water is added to the mix until the concrete is deposited at the paving site. When truck agitators are used, the elapsed time shall not exceed 60 minutes.
- .3 During mixing and transportation of concrete, truck mixers shall be operated at speeds designated by the manufacturer, as shown on the manufacturer's rating plate attached to the drum unit.
- .4 Concrete shall be transported to its final position such that there is no segregation and loss of slump is minimized and the concrete has the required workability and other properties at the point and time of discharge.
- .5 Concrete trucks or truck mixer shall not operate from previously paved lanes until the pavement is at least seven (7) days old or the concrete has achieved 75 percent (75%) of its specified flexural or compressive strength.

#### **4.4 CONCRETE PLACEMENT AND CONSOLIDATION**

- .1 Placing shall be continuous between planned transverse joints without the use of intermediate bulkheads. If concrete pavement is interrupted for more than 30 minutes, transverse construction joints shall be made.
- .2 The concrete shall be placed or subsequently distributed to an even depth. The machine shall spread, screed, compact and float finish the concrete in one pass.
- .3 Reinforcing bars may be inserted through temporary side-forms located behind the paver, or mechanically inserted into the plastic concrete by approved devices associated with the slip form paver. Bars shall be inserted in such a manner that no voids are created around the bar, and no distortion of the pavement surface shall occur.
- .4 The concrete shall be consolidated by internal vibrators of sufficient number, spacing and frequency to provide uniform consolidation to the entire section width and depth. The vibrators shall conform to the requirements of Clause 19.4.2 of CAN/CSA A23.1 -M90. The vibrators shall not operate while the paver is stopped.
- .5 The concrete surface shall be protected from rain until the final set occurs.
- .6 A minimum of 72 hours shall elapse between adjacent pours separated by construction joints or expansion joints.

- .7 The Contractor shall maintain accurate records of cast-in-place concrete items. Record timings, date, location of pour, quantity, air temperature, weather and details of test samples taken.

#### 4.5 CONCRETE FINISHING

- .1 After placing, concrete shall be finished as per the relevant sections of Clause 22 of CAN/CSAA23.1 -M90. Excess finishing is to be avoided. No plaster coat will be allowed. Adding water to the surface of the concrete to assist with finishing will not be allowed.
- .2 Prior to final finishing, the surface grade of concrete slabs shall be checked to an accuracy of plus or minus five (5) mm with a three (3) metre long metal straight edge. The straight edge shall be drawn across the surface in a scraping motion to identify deviations for immediate correction. The straight edge shall be advanced one-half its length for successive checks.
- .3 Following strike-off and consolidation, the concrete surface shall be scraped with an aluminum or magnesium straight edge three (3) metres long, equipped with a handle to permit operation from the edge of the pavement. Any excessive water or laitance shall be removed from the surface before scraping commences.
- .4 Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab (and curb) shall be finished with an edger of the radius shown on the drawings.
- .5 The final surface texture shall be applied, as specified, following the straight edge and edging operation and shall be applied with a broom, a timing device or combination of these methods. If other devices are to be used for imparting surface texture to the concrete, they shall be subject to the approval of the Engineer.
- .6 A broom finish shall be obtained by the use of a stiff, coarse fibre broom. A tined finish shall be obtained by the use of a device having irregularity spaced wire tines with an average spacing of 12 to 18 mm. The device shall be dragged transversely across the surface to form ridges. Transverse texturing shall be delayed until the concrete is sufficiently hard to retain the ridges.
- .7 The Contractor shall always have available material to protect the surface of the plastic concrete from damage from the rain. These materials shall consist of burlap, cotton mats, waterproof paper or plastic sheeting. Protection shall be employed when rain, sufficient to mar the texture of the concrete surface, is expected. The decision of the Engineer in this regard shall be final. When slip-form construction is being used, materials such as wood planks or forms to protect the edges of the section shall also be available.

#### 4.6 CONCRETE CURING

- .1 As soon as practical, after the texturing operation is complete, the entire pavement surface, including exposed sides, shall be cured by protecting it against loss of moisture, rapid temperature change and mechanical injury, in accordance with the requirements of Clause 21 of CSA A23.1 - M90 for Class C-2 concrete.
- .2 The Contractor shall be responsible for taking all necessary measures to protect freshly placed concrete from adverse weather conditions, including hot weather, wind, rain, sleet, snow and cold weather, to the satisfaction of the Engineer. Concrete shall be adequately protected in accordance with the requirements specified in CAN/CSA-A23.1 -M90, Section 21.2.
- .3 Concrete placed when the ambient temperature is at or above 27 C. shall be cured by continuous water curing from soaker hoses or by using saturated absorptive fabric providing complete coverage of the pavement to minimize the temperature rise of the concrete.
- .4 When Polyethylene film sheets (light coloured) or waterproof paper sheets are used, the sheets shall be long enough to cover the entire width and edges of the section and shall be lapped a minimum of 300 mm at joints. The sheets shall be adequately weighed to prevent displacement or billowing due to wind, and material folded down over the side of the edges shall be secured by a continuous bank of earth. Tears or holes appearing in the sheets during the curing period shall be repaired immediately.
- .5 When white liquid membrane forming curing compounds are employed, the compound shall be applied to the exposed surface and edge of the concrete section following the final texturing operation, after all free bleed water has evaporated or been removed from the surface. Complete and uniform coverage, at a rate of three (3) to four (4) m<sup>2</sup>/L shall be required. The compound shall be kept agitated to prevent pigment from settling.
- .6 If the curing compound method of curing is used in combination with sawn control joints, provisions shall be made to cure and protect the exposed faces of the cleaned joint.
- .7 When concrete has been placed in cold weather and the air temperature is expected to drop below 5 C, then straw (or hay) and polyethylene sheets, insulated curing blankets or other suitable material shall be placed beside the concrete members. Whenever the temperature is expected to reach the freezing point, during the day or night, the protective material shall be spread over the concrete surface and weighted to prevent movement to protect the concrete from freezing. Curing shall continue until the cumulative number of days, not necessarily

consecutive, or fraction thereof, during which the temperature of the air in contact with the concrete is above 10 C, has totaled a minimum of seven (7) days. Alternatively, if compressive test of cylinders cured under field conditions achieve at least 70 percent (70%) of the specified compressive strength, curing may be discontinued.

- .8 Concrete placed in cool weather shall experience a minimum 30 day air drying period, following final curing, before the first application of deicing salts.
- .9 Concrete damaged as a result of Inadequate protection against weather conditions shall be removed and replaced by the Contractor at his own expense.

#### 4.7 JOINTS

- .1 Transverse construction control joints, expansion joints and all longitudinal control joints shall be constructed and located as indicated on the drawing, or as required by construction operations.
- .2 Transverse and longitudinal control joints shall consist of planes of weakness created by forming or cutting vertical grooves in the surface. Transverse control joints shall extend to a minimum depth of one-fourth the thickness of the slab. Longitudinal control joints shall extend to a minimum depth of one-fourth the thickness of the slab plus 10 mm.
- .3 Transverse control Joints shall be located as shown on the drawings. The spacing shall not exceed 30 times the thickness of the slab, with a maximum distance of 4.5m between joints. Sidewalk joints shall be provided at a maximum spacing of 1.5m.
- .4 Sawing of joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually within 6 to 18 hours. Joints shall be sawn during day, and night if necessary, in order to prevent uncontrolled shrinkage cracking.
- .5 Sawed grooves forming a reservoir for joint sealant shall be formed by one of the following methods:
  - In two (2) stages, first, by cutting a narrow (3 mm) groove to one-quarter the slab-thickness and a second, by widening the initial groove by secondary sawing to the required sealant-reservoir dimensions.
  - In one operation, using two (2) different diameter (and width) blades simultaneously to achieve the required sealant-reservoir dimensions.

Concurrent with the sawing operation, the grooves shall be cleaned of laitance and grit by high pressure water jets.



- .6 All control joints in lanes adjacent to previously constructed lanes shall be sawed as soon as possible to ensure that uncontrolled cracking will not occur. If extreme conditions make it impractical to prevent erratic cracking by early spring, the transverse control joints shall be formed before the initial set.
- .7 Formed control joints may be made by depressing an approved tool into the plastic concrete or by installing an approved parting strip to the required depth and width. The concrete surface shall be finished by floating across the formed groove, and re-textured if required.
- .8 Transverse control joints shall extend continuously across the mainline pavement and curb or shoulder.
- .9 Transverse construction joints of the type shown on the drawings shall be placed whenever the placing of concrete is to be suspended or interrupted for more than 30 minutes.
- .10 Isolation joints shall be constructed around manhole or catch basin locations and against existing structures or objects within or abutting the concrete, and at intersections as shown on the drawings or as directed by the Engineer. The isolation joint filler shall be held in a vertical position, and shall be continuous from edge with no gaps or offsets between adjacent pieces. An approved installing bar or other device or method shall be used, if necessary, to ensure proper grade and alignment of the filler during placement and finishing of the concrete. The finished joint shall be checked with a straight-edge and any irregularities corrected. The Joint shall not deviate in horizontal alignment more than 6 mm from a straight line.

#### **4.8 JOINT SEALING**

- .1 The joints shall be thoroughly cleaned of all dirt, loose mortar particles and other foreign material lodged in the Joints. After this cleaning and Immediately before applying the joint sealer, the joint shall be wire brushed and blown out with an air jet having sufficient volume and pressure to remove dust and loose material remaining after the cleaning operation.
- .2 The joint shall then be filled with joint sealer to the depth shown the Drawings using an approved mechanical pressure joint filling system. Overfilling joints shall not be permitted. Overfilled joints shall have excess material removed to the satisfaction of the Engineer.
- .3 The joint must be surface dry at the time of filling, and the ambient temperature must be at least 4 C and rising.

#### **4.9 OPENING TO TRAFFIC**

- .1 In no case shall traffic or construction equipment be allowed on the concrete until the concrete has reached a minimum in situ compressive strength of 20 MPa, as determined by adequate number of field cured cylinder testing.
- .2 If an early opening requirement is included for pavements in the Contract, a compressive strength of 25 MPa shall be attained within the specified opening time.
- .3 The Engineer's decision as to when the pavement will be opened to traffic shall be final.

#### **5.0 QUALITY CONTROL**

##### **5.1 INSPECTION**

- .1 All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Engineer including all operations from the selection and production of materials through 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.

##### **5.2 ACCESS**

- .1 The Engineer or a designate 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.

##### **5.3 DISPOSAL OF REJECTED MATERIAL AND REPAIR OF DEFECTS**

- .1 Condemned or rejected material shall be immediately removed from the work and disposed of as directed by the Engineer.
- .2 All defects or imperfections due to rain, frost, trespass, improper workmanship or materials appearing before final acceptance of the work shall be repaired to the satisfaction of the Engineer by the Contractor at his own expense.

**6.0 ACCEPTANCE REQUIREMENTS**

**6.1 GENERAL**

- .1 The pavement acceptance criteria shall include tests for thickness, surface smoothness, and compressive strength.

**6.2 THICKNESS**

- .1 At the opinion of the Engineer, the thickness of the concrete members may be determined by coring section representing each day's pour and determining the depth of each core by average measurements of the core.
- .2 Members found deficient in thickness by more than 5 percent shall be paid for at the reduced price as follows:

of	Deficiency in Pavement	Payment, Percentage
	<u>Thickness ( mm)</u>	<u>Contract Unit Price</u>
	5	100
	15	75
	20	50
	25 or Greater	Removal and Replace

- .3 The cost of initial quality assurance core testing shall be tested Engineer. Additional cores requested by the Contractor to determine the extent of areas deficient thickness shall be paid for by the Contractor.

**6.3 SURFACE SMOOTHNESS**

- .1 The finished surface of pavements shall be tested for smoothness by use of a 3 m long straight edge placed parallel to the centre line of the pavement in each wheel line or by use of a mechanical multiple wheel profilograph to determine the Profile Index. Ordinates measured from the face of the straight edge to the surface of the pavement shall at no place exceed 6 MM.
- .2 Areas that do not meet the required surface accuracy shall be clearly marked out, and the Contractor shall, at his own expense:
  - Grind down any areas higher than 6 mm but not higher than 12 mm above the correct surface, as measured by the straight edge.
  - Correct any areas lower than 6 mm but not lower than 12 mm below the adjacent concrete surface as measured by the straight edge by grinding down the adjacent high areas.

- Break out and replace sections where the straight edge deviation exceeds 12 mm from the correct surface. The volume of concrete removed and the method of removal shall permit the formation of a new slab of the required quality which is in no way inferior to the adjacent undisturbed slab.

- .3 All grinding shall be carried out by an approved machine of a type and capacity suitable for the total area of grinding involved until the surface meets the specified requirements. The texture requirements of Clause 4.5 of this specification shall be complied with following the grinding operation.

#### **6.4 CONCRETE COMPRESSIVE STRENGTH**

- .1 In the case where the compressive strength of the test cylinders for any portion of the work falls below the requirements specified herein, the City shall require the following.

- Where the 28 day strength of the test cylinder is under 25 MPa but over 20 MPa, the work shall, at the discretion of the Engineer, be completely removed and replaced or covered by a five year Maintenance Bond, either of which shall be at the Contractor's expense. The limits of the location covered by this Maintenance Bond shall be the measured length of the block or as determined by the Engineer.

- The amount of the five (5) year Maintenance Bond shall be 25 percent (25%) of the measured area of length of the work multiplied by the unit price submitted in the Tender Form.

- .2 Where the 28 day compressive strength of the test cylinder is under 20 MPa, the City may require complete replacement of the work, the limits of the location of which shall be the measured length of the block or as determined by the Engineer. The replaced work shall be subject to the terms and conditions of this Contract.