

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 31 05 16 Aggregate Materials

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .1 ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .2 ASTM D1883, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - .3 ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2, Sieves, Testing, Woven Wire, Metric.
- .3 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 700 – Specifications for Granular Base Course [January 2008]
 - .2 Manitoba Infrastructure and Transportation Construction Specification 900 – Specifications for Aggregate for Granular Base Course [August 2015]

1.3 SUPPLEMENTAL CONDITIONS

- .1 Material shall be provided to match the aggregate specifications for Drainage Stabilized Base (Granular Base Course – Class DSB) specified in Section 2.1.1.

Part 2 Products

2.1 MATERIALS

- .1 Granular Base Course: material in accordance with Class DSB and the following requirements:
 - .1 Crushed gravel or crushed stone (quarried)
 - .2 Gradations to be within limits specified with the listed sieve sizes.

Granular Base Course – Class DSB:

Passing Standard Sieves	Crushed Gravel or Granite	Crushed Limestone
37.5 mm	100 %	100 %
25 mm	90-100%	95-100 %
19 mm	70-90 %	80-95 %
16 mm	-	-
9.5 mm	40-65 %	40-75 %
4.75 mm	25-45 %	20-50 %
2.00 mm	15-35 %	10-35 %
0.425 mm	0-20 %	5-20 %
0.075 mm	0-8 %	0-6 %
Minimum Crush Count	See Section 2.1.1.2.1	See Section 2.1.1.2.2
Maximum		
a) Los Angeles Abrasion Loss	35 %	35 %
b) Shale Content	3 %	3 %

- .1 For crushed gravel, a minimum 50% by weight of material larger than 4.75 mm shall consist of particles with one freshly fractured face.
- .2 For crushed stone (quarried), a minimum 90% by weight of material larger than 4.75 mm shall consist of particles with two or more freshly fractured faces.
- .3 Material to be free of clay ball, organic and other deleterious substances.
- .4 Materials finer than the No. 40 sieve shall be non-plastic when tested for plasticity in accordance with ASTM D4318.

Part 3 Execution

3.1 PREPARATION

- .1 Preparation
 - .1 Surface preparation shall be performed on all existing unpaved surfaces prior to placing granular base course thereon. The surface shall be prepared at least one but not more than three kilometres in advance of placing granular base course. Material that is blade mixed and watered shall be compacted in maximum lifts of 150 mm to a minimum of 95% AASHTO Standard Dry Density. Surfaces shall be maintained to the required cross section and density, free from ruts and waves until covered by a lift of base course
 - .2 Type “A” Surface Preparation
 - .1 Type “A” Surface Preparation shall be performed where no provision is made for Type “B”, Type “C” or Type “D” Surface Preparation
 - .2 The work shall consist of using motor graders to spread loose gravel that is on the surface of the roadway or in windrows on the shoulders. The

material shall be compacted prior to constructing a granular base course thereon

- .3 Type "B" Surface Preparation
 - .1 Type "B" Surface Preparation shall consist of re-shaping the subgrade to proper cross section by subcutting the surface to a maximum depth of 100 mm. The re-shaped subgrade shall be compacted prior to constructing a granular base course thereon
- .4 Type "C" Surface Preparation
 - .1 Type "C" Surface Preparation shall consist of re-shaping and compacting the subgrade by scarifying to a sufficient depth (not exceeding 250 mm) so as to produce a 150 mm depth of reconstructed subgrade at the required cross-section
 - .2 During Type "C" Surface Preparation, the provisions for In Situ Moisture will apply for drying material that is deemed to be excessively wet.
- .5 Type "D" Surface Preparation
 - .1 Type "D" Surface Preparation shall consist of subcutting the surface to a maximum depth of 250 mm and windrowing the material. The material below the subcut shall be aerated or scarified to a depth of 150 mm and compacted. The windrowed material shall then be blade mixed, spread and shaped to the required profile and cross-section and compacted
 - .2 In general, Type "D" Surface Preparation shall be performed on not more than one-half of the roadway width at any one time with the subcut material being placed in windrow on the other portion of the roadway.

3.2 PLACEMENT AND INSTALLATION

- .1 Place granular base after sub-base surface is inspected and approved in writing by Departmental Representative.
- .2 Placing and Spreading
 - .1 Restricted Hauling
 - .1 Hauling and depositing granular base course will not be permitted until frost-free ground conditions exist in the upper 750 mm of the embankment
 - .2 Road Mixed Based Course
 - .1 The following shall apply unless otherwise approved by the Engineer:
 - .2 Granular base course shall be hauled to the road, deposited, and uniformly windrowed on the prepared surface. The quantity of base course hauled and deposited shall not exceed the quantity for a 100 mm compacted lift.
 - .3 Base course in each work area shall be deposited for not more than 2.5 km in advance of spreading and compacting operations.
 - .4 The length of exposed Class "C" base course in any area shall not be greater than 3 km. Class "C" base course shall not be hauled to the road until sufficient Class "A" base course is in stockpile to cover it.

- .5 Windrowed base course shall be spread by motor grader and manipulated to eliminate segregation and to uniformly incorporate water or dilute emulsified asphalt required for compaction. Each lift shall be spread to the full width of the prepared surface and shall be shaped to the required cross-section
- .3 Pugmill Mixed Based Course
 - .1 Hauling, spreading and compaction equipment used for a pug mill mixed base course shall be of sufficient size and capacity to ensure continuous operation of the pugmill.
 - .2 Pugmill mixed base course hauled to the road shall be spread with an approved hopper- equipped mechanical spreader to the specified width and cross-section and to a depth not exceeding 150 mm when compacted.
 - .3 The moisture content of the aggregate received at the road shall be within the range of optimum to 2% below optimum.
 - .4 The length of roadway which may be covered with uncompacted base course will be as discussed and agreed to at the Pre-Construction Meeting.
- .3 Compaction of Granular Base Course
 - .1 Granular base course shall be compacted using pneumatic tired rollers or other approved equipment. Water or dilute emulsified asphalt shall be added as required to ensure aggregate compaction at the optimum moisture content.
 - .2 Each layer shall be compacted full width to a minimum density of 98% AASHTO standard dry density. Blading will be required in conjunction with the rolling operations to maintain the specified cross section. The Contractor shall not place additional material on a compacted layer until the moisture content of the layer is at or below optimum.
 - .3 If the Contractor conducts the work in such a manner that the mixed materials become segregated, the Contractor shall scarify, re-mix, re-shape and re-compact the layer.
- .4 Maintenance of Lift
 - .1 The Contractor shall maintain each lift of base course material constructed under the terms of the contract. Where inclement weather or traffic necessitates re-shaping, re-laying or re- compaction of a completed base course such work will be considered as incidental to the construction of the base course.
 - .2 If re-laying, re-shaping or re-compacting is required after the Section has been accepted by the Department, the Contractor shall, at the Engineer's request, perform the work on the basis of Extra Work.
- .5 Trimming
 - .1 As a final operation the Contractor shall restore the slopes to a condition equal to that prevailing prior to the commencement of construction. This work will include bringing up and spreading any material that may have been pushed over the shoulders or down the slopes during construction operations and levelling vehicle tracks made by the Contractor's equipment.

- .6 Acceptance of Base Course on Asphalt Surface Treatment Projects
 - .1 The Departmental Representative will not provide final acceptance on the top lift of Class "A" granular base course which is laid after October 15.
 - .2 Base course that is laid after October 15 will be primed providing that ground and atmospheric conditions are suitable. The decision to prime after October 15 will not imply acceptance of the base course. If it is necessary to relay the base course the following construction season, the work shall be done at the expense of the Contractor
- .7 Compaction
 - .1 Compact Granular Base Course – Class DSB to 98% AASHTO standard dry density (proctor).
 - .2 If insufficient fines are present to determine the proctor, the control strip procedure shall be used to confirm the required compaction.
- .8 Control Strip Procedure
 - .1 Construct a short control strip in the field which shall be compacted by an approved method until no further increase in density is recorded.
 - .2 The maximum dry density of the control strip shall be used as the standard dry density (proctor)

3.3 SITE TOLERANCES

- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 32 12 16 Asphalt Paving

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM D140/D140M, Standard Practice for Sampling Bituminous Materials.
 - .2 ASTM D633, Standard Volume Correction Table for Road Tar.
 - .3 ASTM D1250, Standard Guide for Use of the Petroleum Measurement Tables.
- .2 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 805, Prime Coat, Blotter and Tack Coat [January 2008]

1.3 QUALITY ASSURANCE

- .1 Upon request from Departmental Representative, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 When asphalt products are transported to the job site storage by means of tank trucks, the Contractor shall perform the following at his own expense and to the satisfaction of the Departmental Representative:
 - .1 Arrange with the supplying company the points of delivery and the time and quantity to be shipped. Deliveries shall be made during hours when staff of the Department are normally working on the project. When requested, the Contractor shall supply the Departmental Representative with a copy of orders and instructions respecting the shipment.
 - .2 Provide and maintain a storage area, and upon completion of the work restore the area to a satisfactory condition.
 - .3 Provide storage facilities of sufficient capacity to store all asphalt products ordered to the job site.
 - .4 When requested, calibrate storage tanks and make calibration tables or charts available to the Departmental Representative prior to the start of operations, and make convenient provision for samples of asphalt products to be taken from storage tanks by the Departmental Representative.
 - .5 Make provision for the Department to verify the quantity of asphalt products delivered in trucks, by weighing the truck or dipping the truck tank, before and after unloading.
 - .6 Axle loadings will be permitted for the verification of asphalt products delivered. In the case of dipping, the Contractor shall provide:
 - .1 an inspection platform, meeting the requirements of the Workplace Safety and Health Act,

- .2 a dipstick to verify the level of asphalt in the tank.
- .7 Provide suitable unloading facilities and unload the asphalt product.
- .8 Pay overtime standby charges for the Supplier's trucks except when the Supplier is responsible for the delay. Overtime standby is defined as the waiting period at the job site unloading point, after a free waiting time allowance of 2½ hours has been exceeded for unloading any delivery of ordered asphalt product.
- .9 Pay transportation charges on asphalt products returned to the Supplier for all causes, except in the case of the Supplier making a faulty delivery.
- .2 The Contractor will be permitted to order a partial load of tack coat to complete the work.

Part 2 Products

2.1 MATERIALS

- .1 Aggregate for Blotter Sand:

Passing Standard Sieves	Blotter Sand Type I	Blotter Sand Type II
12.5 mm	100 %	100 %
0.425 mm	0-25 %	0-50 %
0.075 mm	0-5 %	0-10 %

- .1 Water: clean, potable, free from foreign matter.
- .2 Asphalt Product: Emulsified Asphalt SS-1

2.2 EQUIPMENT

- .1 Equipment required for this work shall be in satisfactory working condition and so maintained for the duration of the work
- .2 Equipment shall be on the site and available for inspection, testing and approval before the work commences.
- .3 Asphalt Pressure Distributor:
 - .1 The distributor used in applying asphalt products shall be constructed and equipped to maintain a sufficient and uniform pressure the full length of the spray bar so as to uniformly and completely cover the road surface at rates approved by the Departmental Representative. It shall be equipped with:
 - .1 A heating unit capable of maintaining the asphalt product in the tank at the specified Temperature.
 - .2 A thermometer so placed as to accurately measure the temperature of the asphalt product in the tank.
 - .3 A spray bar that can be adjusted in increments of 0.6 metres and capable of being raised or lowered.
 - .4 Spray nozzles, with quick acting positive shutoff, of a design which will ensure a uniform fan-shaped spray.
 - .5 A hose and nozzle attachment to be used for spraying, by hand, areas inaccessible to the distributor spray bar.
 - .6 A gauge to indicate volume of product in the distributor.

- .2 Aggregate Spreader
 - .1 A roll type spreader, or rotating disc sander capable of applying aggregate at variable widths and at variable rates, shall be used to apply blotter sand to primed surfaces.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt tack coat installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 BLOTTER SAND

- .1 Blotter sand shall be applied where required on primed surfaces.
- .2 Traffic conditions may require sanding to be undertaken immediately. Blotter sand shall be applied lightly at a rate not to exceed 60 m³ per lane kilometer based on a 4.0 m wide lane (0.015 m³ per m²). Blotter sand shall not be rolled.

3.3 TACK COAT

- .1 A tack coat shall be applied prior to constructing a lift of bituminous pavement on sanded primed surfaces, on unsanded primed base course surfaces that have become dry, dusty or dirty, and on previously paved or concrete surfaces. The tack coat will be left uncovered long enough for the SS-1 to break prior to placing the bituminous pavement.
- .2 Existing surfaces shall be cleaned, immediately prior to tack coating, using equipment which will leave the surface dry and free from dust, dirt and other unacceptable material.
- .3 The Contractor shall tack coat with undiluted SS-1 emulsified asphalt. Depending on the site conditions, application rates may have to be adjusted.
- .4 Tack coat shall be limited to one lane at a time and shall extend to but not beyond the edge of the proposed pavement surface. The length of lane tack coated will be limited to the required for a one-half day paving operation. The Contractor shall prevent any unnecessary passage of traffic upon the area tack coated until a lift of bituminous pavement has been placed thereon.

3.4 PROTECTION OF CURBING

- .1 The Contractor shall protect concrete curbing prior to priming granular base course or tacking adjacent pavement. The protection shall be in the form of plastic sheeting fastened securely over the curbing or by some other approved method. If plastic sheeting is used it shall be left in place until the prime coat has cured.

3.5 SPRAYING TEMPERATURES

- .1 Asphalt products shall be sprayed within the following temperature ranges:
 - .1 SS-1: 5 - 40°C

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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 - .2 Provide and maintain a storage area, and upon completion of the work restore the area to a satisfactory condition.
 - .3 Provide storage facilities of sufficient capacity to store all asphalt products ordered to the job site.
 - .4 When requested, calibrate storage tanks and make calibration tables or charts available to the Departmental Representative prior to the start of operations, and make convenient provision for samples of asphalt products to be taken from storage tanks by the Departmental Representative.
 - .5 Make provision for the Department to verify the quantity of asphalt products delivered in trucks, by weighing the truck or dipping the truck tank, before and after unloading.
 - .6 Axle loadings will be permitted for the verification of asphalt products delivered. In the case of dipping, the Contractor shall provide:
 - .1 an inspection platform, meeting the requirements of the Workplace Safety and Health Act,

- .2 a dipstick to verify the level of asphalt in the tank.
- .7 Provide suitable unloading facilities and unload the asphalt product.
- .8 Pay overtime standby charges for the Supplier's trucks except when the Supplier is responsible for the delay. Overtime standby is defined as the waiting period at the job site unloading point, after a free waiting time allowance of 2½ hours has been exceeded for unloading any delivery of ordered asphalt product.
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 - .2 A thermometer so placed as to accurately measure the temperature of the asphalt product in the tank.
 - .3 A spray bar that can be adjusted in increments of 0.6 metres and capable of being raised or lowered.
 - .4 Spray nozzles, with quick acting positive shutoff, of a design which will ensure a uniform fan-shaped spray.
 - .5 A hose and nozzle attachment to be used for spraying, by hand, areas inaccessible to the distributor spray bar.

- .6 A gauge to indicate volume of product in the distributor.
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 - .1 A roll type spreader, or rotating disc sander capable of applying aggregate at variable widths and at variable rates, shall be used to apply blotter sand to primed surfaces.

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3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt tack coat installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PRIME COAT

- .1 The prime coat shall be applied to the prepared base at such locations and rates of application as are specified by the Departmental Representative.
- .2 SS-1 when used as prime shall be roadmixed into the top 25 - 50 mm of the granular base course at an approximate rate of 10 l/t (1.1 l/m²) of undiluted SS-1. The underlying base shall be well compacted and dried back to optimum moisture content or less prior to the incorporation of the SS-1. In no case shall this material be placed and compacted prior to the addition of the SS-1.
- .3 As a final operation in priming, the surface of the base course shall be flushed with the same SS-1 mixture and compacted. When traffic flow must be maintained, this operation shall be done on one-half of the roadway at a time. No final flushing shall commence on the second half of the roadway until the emulsion sprayed on the first half has sufficiently dried to accommodate vehicular traffic.

3.3 BLOTTER SAND

- .1 Blotter sand shall be applied where required on primed surfaces.
- .2 Traffic conditions may require sanding to be undertaken immediately. Blotter sand shall be applied lightly at a rate not to exceed 60 m³ per lane kilometer based on a 4.0 m wide lane (0.015 m³ per m²). Blotter sand shall not be rolled.

3.4 PROTECTION OF CURBING

- .1 The Contractor shall protect concrete curbing prior to priming granular base course or tacking adjacent pavement. The protection shall be in the form of plastic sheeting fastened securely over the curbing or by some other approved method. If plastic sheeting is used it shall be left in place until the prime coat has cured.

3.5 SPRAYING TEMPERATURES

- .1 Asphalt products shall be sprayed within the following temperature ranges:
 - .1 SS-1: 5 - 40°C

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 32 12 13.26 Asphalt Prime Coats
- .2 Specification 32 12 13.16 Asphalt Tack Coat
- .3 Specification 32 17 23 Pavement Marking

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
 - .2 ASTM C127, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
 - .3 ASTM C128, Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate
 - .4 ASTM C131, Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
 - .5 ASTM C136, Standard Method of Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
 - .6 ASTM D75, Standard Methods of Sampling Aggregates
 - .7 ASTM D242, Standard Specification for Mineral Filler for Bituminous Paving Mixtures
 - .8 ASTM D979, Standard Methods of Sampling Bituminous Paving Mixtures
 - .9 ASTM D995, Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
 - .10 ASTM D1559, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
 - .11 ASTM D2172, Standard Methods of Test of Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
- .2 City of Winnipeg
 - .1 City of Winnipeg Standard Construction Specification CW3410 – Asphaltic Concrete Pavement Works [December 2015]
- .3 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 800(I), Bituminous Pavement and Recycled Bituminous Pavement [March 2015]
 - .2 Manitoba Infrastructure and Transportation Construction Specification 920 – Specifications for Aggregate for Bituminous Pavement [August 2015]

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.
- .2 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.
- .3 Provide approved storage, heating tanks and pumping facilities for asphalt cement.

Part 2 Products

2.1 MATERIALS

- .1 Aggregates
 - .1 Fine Aggregate
 - .1 Fine aggregate shall consist of sand having clean, hard, strong, durable, uncoated grains free from injurious amounts of dust, soft or flaking particles, shale, alkali, organic matter, loam or other deleterious substances
 - .2 Course Aggregate
 - .1 Coarse aggregate shall consist of natural gravel, crushed stone or other approved materials of similar characteristics having clean, hard, strong, durable, uncoated particles free from injurious amounts of soft, friable, thin, elongated or laminated pieces, alkali, organic or other deleterious matter
 - .2 Crushed stone shall consist of angular, cubical fragments of aggregate of uniform quality throughout. It shall be produced from rock formations or from boulders and stones and shall be from sources of approved nature and origin. Coarse aggregate will not be accepted from rock formations or from boulders and stones containing intrusions or stratifications of an undesirable nature or from source showing signs of disintegration from the elements or other causes.
 - .3 Coarse aggregate shall conform to the following additional requirements:
 - .1 Soundness - Coarse aggregate when subjected to five cycles of the soundness test shall have a weighted loss of not more than twelve (12%) percent when sodium sulphate is used or not more than eighteen (18%) percent when magnesium sulphate is used, or have in the opinion of the Departmental Representative a satisfactory soundness record. The method of testing shall be in accordance with ASTM Standard C88, Test for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate
 - .2 Abrasion - Coarse aggregate when subjected to the abrasion test shall have a loss of not more than thirty-five (35%) percent by weight, of any hand picked portion of a sample containing a

minimum of one and a half (1.5%) percent by weight of the original sample. The method of testing shall be in accordance with ASTM Standard C131, Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.

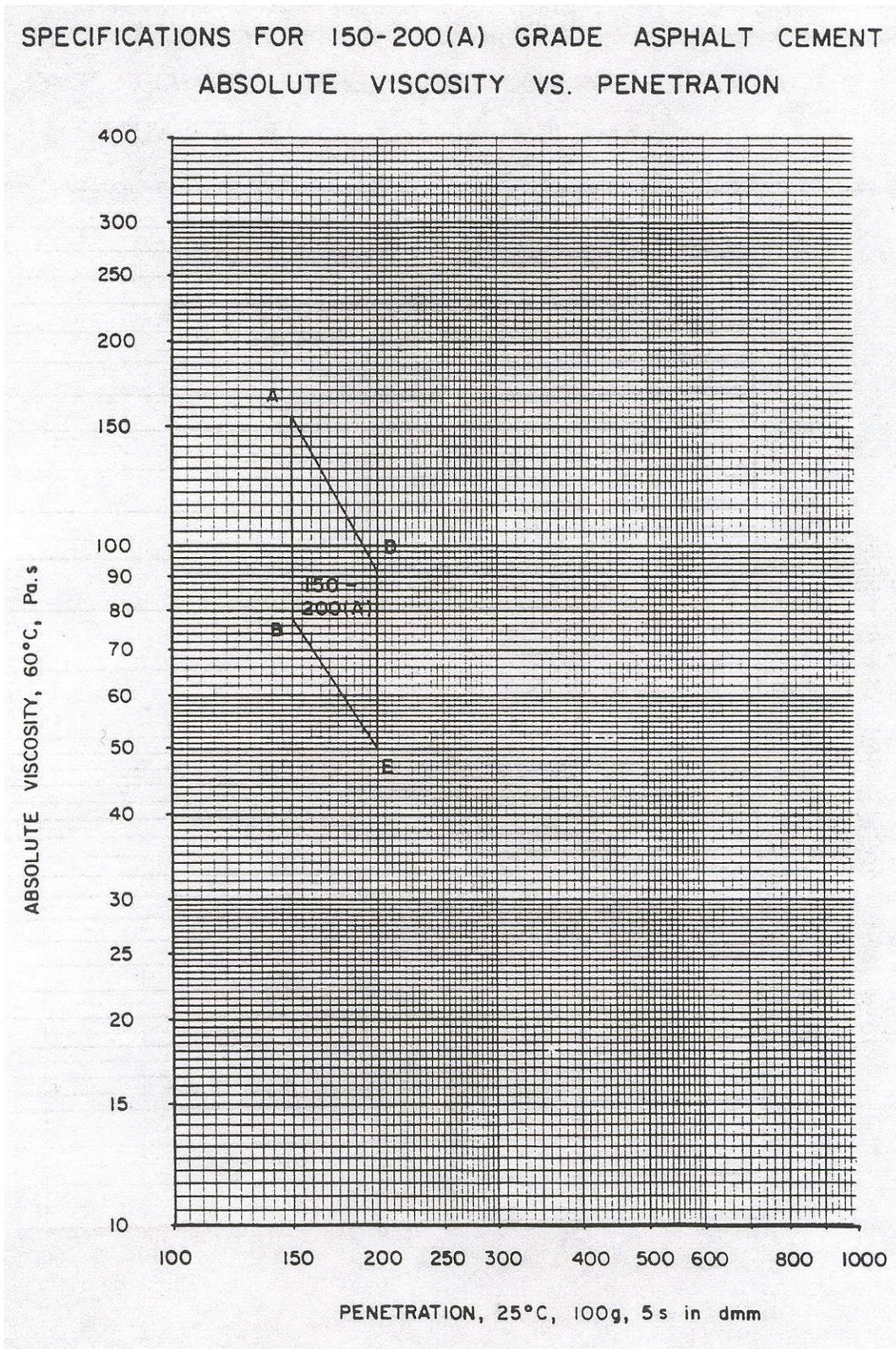
.3 Crushed Aggregate - Aggregate retained on a No. 5 000 sieve shall contain not less than the percent of crushed aggregate as determined by actual particle count and as shown in the Table 1.

.2 Asphalt Cement

.1 The asphalt cement shall be prepared by the refining of petroleum, it shall be uniform in character and shall not foam when heated to 175°C.

.2 150 - 200(A) Grade asphalt cement shall conform to the requirements specified the following table:

Test Characteristics	ASTM Test	150-200 (A)		
Kinematic Viscosity (135°C, mm ² /s)	D2171	The viscosity and penetration values must fall within the area bounded by A to B to C to D to A, plotted as straight lines on a full logarithmic plot (log-log) as shown on Figure 1, with the co-ordinates of the points as follows:		
Penetration (25°C, 100 g, 5 s in dmm)	D5	Point	Abs. Visc	Pen.
		A	360	150
		B	255	150
		C	205	200
		D	285	200
Flash Point, Cleveland Open Cup (minimum °C)	D92	205		
Solubility in Trichloroethylene (minimum %)	D2042	99.5		
Tests on Residue from Thin-Film Oven Test: Ratio of Absolute Viscosity of Residue from Thin-Film Oven Test to Original Absolute Viscosity (max)	D1754	4.0		
Ductility, 25°C, 5 cm/min., min., cm	D2171	100		
15.56°C, 5 cm/min., min., cm	D113	--		



SPECIFICATIONS FOR 150-200(A) GRADE ASPHALT CEMENT KINEMATIC VISCOSITY VS. PENETRATION

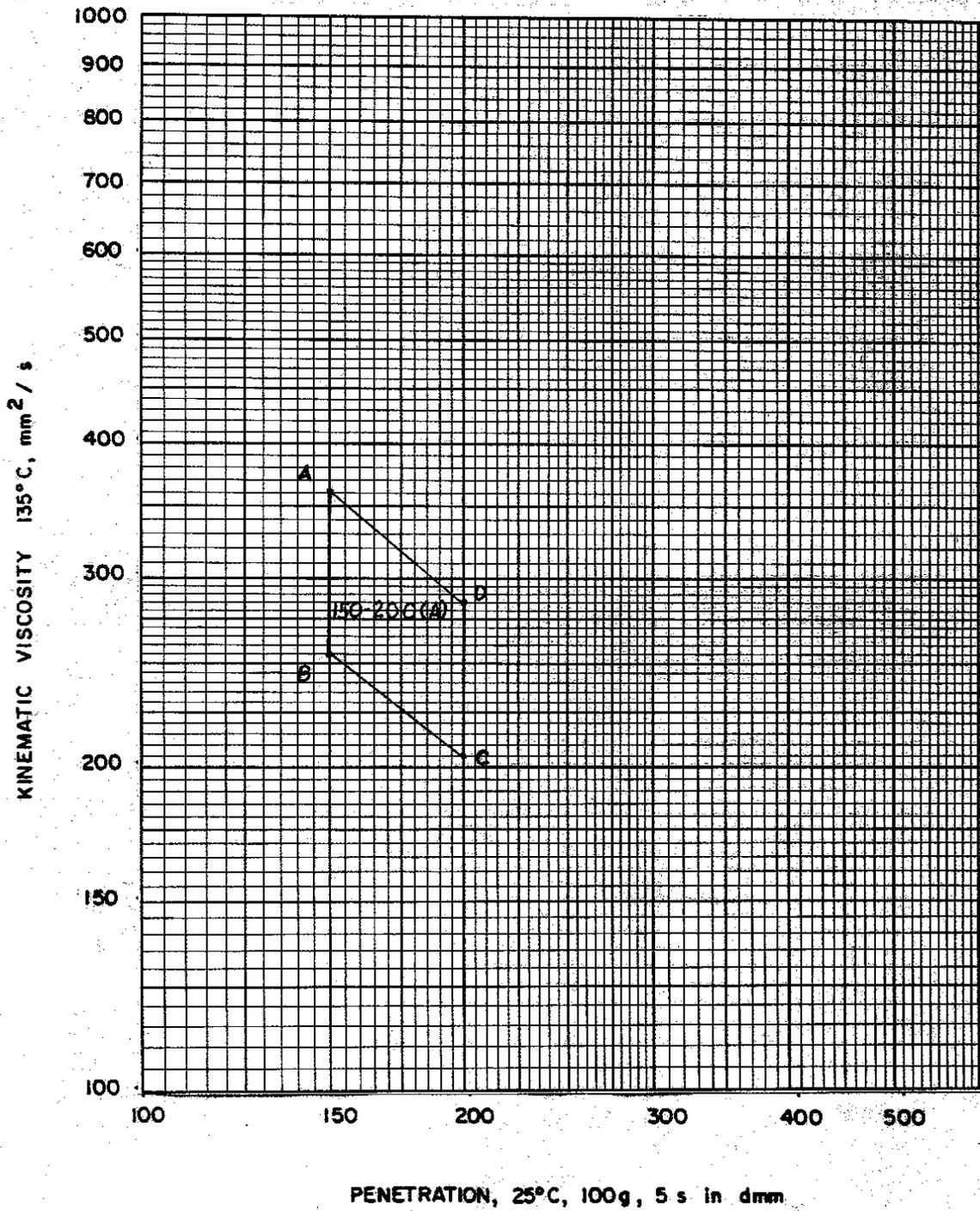


FIGURE 2

- .3 Mineral Filler
 - .1 Mineral filler, when required, shall consist of finely divided mineral matter such as rock dust, slag dust, hydrated lime, hydraulic cement, fly ash, loess or other suitable mineral matter, and shall conform to the requirements of ASTM Standard D242, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.

2.2 EQUIPMENT

- .1 Inspection of Plant and Equipment
 - .1 Equipment required for this work shall be in satisfactory working condition and so maintained for the duration of the work.
 - .2 Equipment shall be on the site and available for inspection, testing and approval before paving operations commence.
 - .3 The Departmental Representative shall have access to all parts of the plant and equipment for purposes pertaining to the work.
- .2 Mixing Plants
 - .1 The plant shall be one of the following types: Drum Mix Plant, Continuous Mix Plant or Batch Mix Plant.
 - .2 The output of the plant shall be as approved by the Departmental Representative, and within the manufacturer's specifications, with regard to plant size, discharge, temperature and the amount of moisture that must be removed from the aggregate.
 - .3 Drum Mix Plants to ASTM 995
 - .1 Cold Aggregate Feed
 - .1 The cold aggregate feed unit shall contain separate bins for each aggregate, supplementary material and V.M.A. additive. Combining of these materials to meet the mix design shall be accomplished by means of adjustable gates and variable speed feed belts on each bin. The Contractor shall provide vibrators or other devices as may be required to ensure a uniform flow of material from each bin.
 - .2 The Contractor shall provide a vibrating screener on the main feed belt. The maximum size of the screen opening shall be: Virgin mixes 37.5mm. Field conditions may necessitate a smaller screen.
 - .3 The total flow of aggregate shall be metered by an electronic weigh belt system which has an indicator that can be monitored by the plant operator, and which is interlocked with a variable speed asphalt cement pump so that the proportions of aggregate and asphalt cement entering the drier-mixer remain constant.
 - .2 Plant Operation and Controls
 - .1 The weighing systems for aggregates and asphalt cement shall have provision to enable convenient calibration without having the material enter the drier-mixer.

- .2 The heating, coating and mixing of the bituminous material shall be accomplished in a parallel flow drier-mixer. Heating shall be controlled to prevent fracture of the aggregate or excessive oxydization of the asphalt cement. The system shall be equipped with automatic burner controls and shall provide for continuous temperature sensing of the bituminous material at discharge, with a printing recorder that can be monitored by the plant operator. The printed record of mix temperatures shall, if requested, be delivered to the Departmental Representative at the end of each week.
- .3 The mixing period and temperature shall be such as to produce a uniform mixture in which all the particles are thoroughly coated with asphalt cement. The asphalt cement metering system shall be capable of controlling the asphalt cement content of the mix to within plus or minus 0.2%.
- .4 The control panel for a drum mix plant shall have the following indicators, recorders and controls:
 - .1 Individual variable quantity feed controls which govern the output from each feed bin and a master variable quantity feed control which governs the combined output from the bin feeders.
 - .2 A belt scale totalizer showing accumulated weight of aggregate delivered to the drier-mixer.
 - .3 Provision for compensating for the moisture content of the material in each or all of the feed bins.
 - .4 An indicator showing the computed total weight per hour of aggregate (corrected for moisture content) delivered to the drier-mixer.
 - .5 A control for setting the required percentage of asphalt cement based on the weight of dry aggregate and a control to allow for a change in the specific gravity of asphalt cement.
 - .6 A counter from which the accumulated volume of asphalt cement delivered to the drier-mixer can be determined, but excluding asphalt cement being circulated in the storage tanks.
 - .7 A continuously recording instrument to indicate mix temperature at discharge from the drier-mixer.
 - .8 A master switch to start the asphalt cement and aggregate feeds simultaneously and a master switch to stop the asphalt cement and aggregate feeds simultaneously.
- .3 Storage for Bituminous Material
 - .1 A metal storage bin covered with either a metal top, insulated tarpulin or other approved covering which:

- .1 has a capacity equal to at least 20% of the Manufacturer's maximum rated production per hour of the drier-mixer; and
 - .2 has material introduced to it through an automatically controlled batching device; and
 - .3 is equipped with strain gauges or high and low level lights; and
 - .4 is elevated and discharges bituminous material through the base of the silo directly into hauling vehicles.
- .4 Continuous Mix and Batch Mix Plant to ASTM 995
- .1 Cold Aggregate Feed
 - .1 Separate aggregate feeds capable of delivering a uniform flow of material to the drier shall be provided for each separate stockpile of aggregate, supplementary material and V.M.A. additive being used to produce the final mix.
 - .2 Where blending of materials from one or more sources is required to meet the Specifications, materials shall be placed in separate stockpiles.
 - .2 Plant Operation and Controls
 - .1 The plant shall be equipped with interlocking automatic controls to ensure that;
 - .1 The operation of the plant is independent of any operator; and
 - .2 The correct proportioning of the aggregates and the asphalt cement is achieved.
 - .2 Continuous mix plants shall contain an asphalt cement metering system to accurately indicate the accumulated quantity of asphalt delivered to the pugmill and a pressure gauge located between the meter and the pugmill spray bar.
 - .3 Batch plants shall be equipped with a batch counter.
 - .4 The aggregate shall be fed through the drier where it shall be heated without burning. The plant shall provide for continuous temperature sensing of the dried aggregate at discharge.
 - .5 The drier shall be equipped with a dust collector arranged so that any part or all of the dust may be returned to the hot stone elevator.
 - .6 After drying, the aggregate shall be passed over vibrating screens to separate the aggregate by size into two or more hot bins. The screens shall be kept clean and in good repair at all times. The amount of undersize material in the coarse bin and the amount of oversize material in the fine bin shall remain reasonably constant and shall not be more than ten percent by weight of the total aggregate in any sample taken from any bin.
 - .7 Aggregate shall be mixed dry in the pugmill for not less than 10 seconds. The asphalt cement shall then be added and mixing continued until all aggregate particles are uniformly coated and

the asphalt cement is uniformly distributed throughout the mixed material. The wet mix time shall be not less than 30 seconds.

- .8 The temperatures of the asphalt cement and aggregate entering the pugmill at anytime shall not differ from each other by more than 15°C.
- .9 The automatic controls shall be such that the mixing operation is automatically shut down when;
 - .1 in the case of batch mix plants, there is insufficient material in any one hot bin to make up the batch.
 - .2 in the case of continuous mix plants, the level of the aggregate in any one hot bin drops below one-third full.

2.3 DESIGN REQUIREMENTS

- .1 Mix Design Statement
 - .1 For each type of asphaltic paving mix to be used, the Contractor shall provide the Departmental Representative with a Mix Design Statement certifying the constituent materials and mix proportions that will be used in the asphaltic concrete paving mix. The Contractor shall also supply reasonable evidence to the Departmental Representative that the mix proportions selected will produce asphaltic concrete conforming to the requirements specified in Sections 2.3.2, 2.3.3 and 2.3.4 of this Specification.
 - .2 One (1) week prior to the start of paving the Contractor shall provide the Departmental Representative with the results of three (3) separate sets of Marshall Tests to show that the requirements of the mix design statement have been met. Where a correction of the mix design statement is necessary to reflect actual production, the Contractor will submit to the Departmental Representative a minimum of five (5) separate sets of Marshall test results for approval of the corrected mix design statement. This mix design statement, or revised mix design statement, as necessary, will be called the Job Mix Formula.
 - .3 Should a change occur in the Job Mix Formula during the course of the work, the Contractor shall re-submit to the Departmental Representative a minimum of five (5) separate sets of Marshall test results to support approval of the revision.
 - .4 Should a lengthy break occur in the paving operation, the Departmental Representative may request that the Contractor submit the results of three (3) recent, separate sets of Marshall test results as evidence that the Job Mix Formula is being achieved.
 - .5 No changes in the Job Mix Formula will be permitted without following the above procedure.
- .2 Aggregate Gradation Requirements
 - .1 For each type of paving mixture, the mineral constituents shall be combined in such proportions so as to fall within the Gradation Limits shown in Table 1 - CW 3410-R5.1, unless the Contractor can conclusively show to the Departmental Representative that he can meet the physical requirements specified in Section 2.3.4 only by deviating from these gradation limits
- .3 Allowable Deviation from Job Mix Formula

.1 Aggregate Gradation

- .1 The aggregate gradation of the asphaltic concrete supplied by the Contractor shall not deviate from that of the Job Mix Formula by more than the Allowable Deviations shown hereafter and shall fall within the gradation limits shown:

Maximum Allowable Deviation from Job Mix Formula	
Canadian Metric Sieve Size	Percent of Total Dry Weight Passing Each Sieve
10 000	± 5%
5 000	± 5%
2 500	± 4%
1 250	± 4%
630	± 4%
315	± 4%
160	± 2%
80	± 2%

.2 Asphalt Cement Content

- .1 The asphalt cement content of the asphaltic concrete supplied by the Contractor shall not deviate from that of the Job Mix Formula by more than + 0.4%, provided that the asphalt cement content requirements are maintained in accordance with Table 2.

.4 Physical Requirements

- .1 For each type of paving mixture, the asphaltic concrete paving mix shall conform to the physical requirements shown in Table 2.

.5 Method of Testing

- .1 Quality control tests will be used to determine the acceptability of the asphaltic concrete paving mixture supplied by the Contractor.
- .2 The Departmental Representative shall obtain samples of asphaltic concrete paving mixture and of the constituent materials required for quality control tests. The Contractor shall make no charge for these materials.
- .3 An outline of some of the quality control tests that will be used to check the physical properties of the mixture, and to check the properties, gradations and proportions of the constituent materials is as follows:
- .4 Samples of mineral aggregates shall be taken in accordance with ASTM Standard D75, Standard Methods of Sampling Aggregates.
- .5 Samples of asphaltic concrete paving mixtures shall be taken in accordance with ASTM Standard D979, Standard Methods of Sampling Bituminous Paving Mixtures.
- .6 The determination of the particle size distribution of aggregates shall be made in accordance with ASTM Standard C136, Standard Method of Test for Sieve or Screen Analysis of Fine and Coarse Aggregates.

- .7 The specific gravity of aggregates shall be determined in accordance with ASTM Standard C127, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate, and ASTM Standard C128, Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate.
 - .8 The determination of the percent of asphalt cement in asphaltic concrete paving mixtures and pavement specimens shall be made in accordance with ASTM D2172, Standard Methods of Test of Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.
 - .9 The percent air voids, the percent voids in the mineral aggregate, the Marshall density, Marshall stability and flow index shall be determined in accordance with the Standard Marshall Procedure (75 Blows) and in accordance with ASTM Standard D1559, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus.
- .6 Reclaimed Asphalt Pavement Content
- .1 Reclaimed asphalt pavement (RAP) material may be incorporated to a maximum of 10% by mass of total mix into the Class B mix design for asphalt pavements and overlays.
 - .2 Blending of the reclaimed asphalt pavement material shall be during production and the mix produced shall consist of a uniform blend of all materials.
 - .3 A mix design statement in accordance with Section 2.3.1 shall be submitted to the Departmental Representative for approval.
 - .4 All physical requirements and combined aggregate gradation limits shall meet the requirements of Table 1 and Table 2.

Combined Aggregate Gradation Limits				
Percent of Total Dry Weight Passing Each Sieve				
Canadian Metric Sieve Size	Class B (Surface Course) %	Type I (Surface Course) %	Type II (Surface Course) %	Type III (Base Course) %
40 000				100
25 000				90-100
16 000	99-100	100		60-90
12 500	--	--		26-80
10 000	70-88	70-85	100	--
5 000	55-70	45-70	90-95	29-59
2 500	40-60	25-55	74-80	20-50
1 250	25-50	20-40	55-64	--
630	15-40	15-30	35-46	15-30
315	5-28	5-20	22-30	5-17
160	4-11	11	--	11
80	3-7	3-6	8-11	1-7
Crush Count	60% min	50% min	--	60% min
	(2 fractured faces)	(1 fractured face)		(2 fractured faces)

TABLE 1

Physical Requirements				
	Class B (Surface Course) %	Type I (Surface Course) %	Type II (Surface Course) %	Type III (Base Course) %
Asphalt Cement, % total sample weight	5-6	5-6	5-7	4-5.5
Voids in Mineral Aggregate, VMA	14 min	14.5 min	16.0 min	12.0 min
Air Voids	3-5	2.5-5.0	2.5-5.0	2.5-5.0
Marshall Stability, kN at 60C	7 min	5 min	4 min	5 min
Flow Index	6.0-16.0	6.0-16.0	6.0-16.0	6.0-16.0

TABLE 2

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt paving in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 MIXING BITUMINOUS PAVEMENT

- .1 Prior to commencing mixing operations the plant shall be calibrated by the Departmental Representative. The Contractor shall notify the Departmental Representative at least three days in advance of when the plant will be completely ready for calibration. The Contractor shall supply necessary men and equipment to assist in the calibration. Calibration may commence during the mix design period but mixing operations shall not commence until the mix design is completed.
- .2 The plant settings for asphalt cement, aggregate, supplementary material and V.M.A. additive for the bituminous material shall be established by the Departmental Representative in accordance with the mix design, and adjusted as required by the Departmental Representative during paving operations.
- .3 The bituminous material shall be controlled to maintain the mix design gradation and asphalt cement content which yields the required air voids.
- .4 When mixing operations result in reject mix exceeding an average of 10t/day, the Contractor will be assessed the cost of the asphalt cement in the excess reject mix. The average reject will be calculated on a five day operation.
- .5 During mixing operations, plant checks are required to determine the asphalt cement content and plant output shall be carried out.

- .6 When producing the bituminous material, sufficient aggregate quantities shall be maintained in stockpile at the plant site for at least four days operation of the mixing plant at its rated capacity.
- .7 All aggregate, supplementary material and V.M.A. additive required for the final lift shall be produced prior to commencing the production of the final lift of bituminous material.

3.3 ASPHALT CEMENT WORKING TEMPERATURES

- .1 The asphalt cement shall be heated in a storage tank to a working temperature within the range as specified herein. Provision shall be made for determining the temperature of the asphalt cement at or near the discharge end of the feed line.
- .2 Specified mixing temperature ranges, in degrees Celsius for Asphalt Cement shall apply as follows:
 - .3 120/150 Type "A" 140-160
 - .4 150/200 Type "A" 130-155
 - .5 200/300 Type "A" 130-155
 - .6 300/400 Type "A" 130-155
 - .7 SC 3000 110-120
- .8 The actual mixing temperature within the specified range shall be based upon temperature - viscosity curves.

3.4 HAULING BITUMINOUS MATERIAL

- .1 Truck boxes shall be clean, free from foreign material and lubricated. Truck boxes shall be raised to drain excess lubricant before being loaded with bituminous material.
- .2 Waterproof tarpaulins shall be installed on trucks at all times and shall be spread to cover the truck box completely whenever the Departmental Representative considers the moisture, temperature, wind, length of haul or other conditions will require protection over the bituminous material.
- .3 Bituminous material loaded in excess of the allowable load limits shall be unloaded and, if possible, salvaged by the Contractor.

3.5 LOCATION OF MIXING PLANT

- .1 When the quantity of bituminous pavement to be constructed on any Section on the project:
 - .1 Is 10 000 tonnes or greater, the plant shall be located so that the maximum dead haul from the plant to the point where the bituminous material enters the project does not exceed 40km.
 - .2 Is less than 10 000 tonnes, the plant shall be located so that the maximum deadhaul from the plant to the point where the bituminous material enters the project does not exceed 160km

3.6 MOISTURE CONTENT OF BITUMINOUS MATERIAL

- .1 The moisture content of bituminous paving material shall be one percent or less in mix samples taken from the road immediately behind the spreader.

3.7 LEVELLING COURSE

- .1 A levelling course of bituminous pavement shall be placed over areas of uneven pavement. A paver shall be used unless otherwise permitted.
- .2 A levelling course shall be laid in lifts not exceeding 75mm in depth, and each lift shall be compacted to 97% of Marshall Density. The levelling course shall be properly compacted and shall have cooled to 50°C or lower before placing any further material thereon.

3.8 SPREADING BITUMINOUS MATERIAL

- .1 The Contractor shall maintain the primed base course free from surface breaks and potholes until the pavement has been constructed. Bituminous material shall not be deposited on the highway until the surface is properly prepared and in satisfactory condition.
- .2 Where surface maintenance involves bituminous patching the Contractor shall, at his own expense:
- .3 When the asphalt plant is on site and in operation; supply all equipment, labour and materials except asphalt cement to restore the surface.
- .4 When the asphalt plant is not on site; supply all equipment, labour and materials including asphalt cement to restore the surface.
- .5 The Contractor shall provide sufficient trucks to ensure a continuous supply of bituminous material to the paver.
- .6 Bituminous material shall be spread on the prepared base by means of a self-propelled mechanical paver complete with screed and augers. The paver shall be equipped with both automatic and manual controls capable of adjusting the screed to produce the required profile, cross section and longitudinal joint matching. Unless otherwise permitted the paver shall be operated using automatic controls.
- .7 The automatic control of profile shall be accomplished by reference to a floating beam or skid. The beam or skid shall have a minimum length of 9m. A floating beam shall be supported by wheels or skis in a floating tandem arrangement.
- .8 When paving adjacent to a newly laid lane on final lift or adjacent to a curb, control of profile may be accomplished by reference to a shoe on the adjacent final lift or curb. The paver shall be equipped with a Layton hitch or equivalent. The speed of the paver shall be maintained at a uniform rate that is in balance with the actual plant production, but in no case shall the paver exceed a speed of 25 metres per minute.
- .9 The paver shall produce a uniformly textured surface free from tearing, tracking or other unacceptable surface irregularities. If the surface condition is not acceptable, spreading operations shall cease until equipment adjustments, repairs or replacement are made. Spreading operations shall not re-commence without the approval of the Departmental Representative. Delays and expense entailed in adjustments, repairs or replacement of equipment shall be the responsibility of the Contractor.

- .10 The length of pavement constructed on a lane, shall be controlled so that;
 - .1 On other than top lift, the length of pavement in the adjacent lane is not exceeded by more than one day's normal production.
 - .2 On top lift, the pavement marking tape is applied continuously on the same side of centerline and the length of centerline drop-off is kept to a minimum.
- .11 The bituminous material shall be spread to the width as staked on the ground or as specified by the Departmental Representative. A lift shall consist of not more than 570 tonnes per kilometre for a lane 3.7m wide.
- .12 Where adjacent lanes of bituminous pavement are constructed the Contractor shall paint longitudinal seams with emulsified asphalt cement.
- .13 Where bituminous pavement is to be constructed against a vertical concrete surface, the joint shall be painted with asphalt cement or undiluted emulsified asphalt cement.
- .14 When the bituminous material is produced in two plants for the same project, separate spreading operations will be required for material from each plant unless a common storage silo is used by the Contractor.
- .15 Spreading and compacting operations shall be restricted to the hours between official sunrise and official sunset.

3.9 WEATHER LIMITATIONS

- .1 The top lift of bituminous pavement shall be placed only when the surface is dry. The atmospheric temperature shall be a minimum 6°C and rising for projects with a deadhaul of 40 km or less and not less than 10°C and rising for projects with deadhauls exceeding 40km. If the wind velocity exceeds 10km/hour the atmospheric temperature shall be at least 10°C and rising.
- .2 Lifts other than the top lift may be placed when the surface is dry and the atmospheric temperature 150mm above the surface to be paved is not less than 0°C and rising.
- .3 Notwithstanding the above, when weather conditions are unfavourable, or are likely to become unfavourable, paving operations may be suspended.

3.10 RESTRICTED PAVING

- .1 Construction of bituminous pavement will not be permitted until frost-free ground conditions exist in the upper 750mm of the embankment.
- .2 Construction of the top lift of bituminous pavement may be permitted after October 15 providing the specifications are met and the pavement is matched daily on adjacent lanes and paved shoulders.

3.11 COMPACTING BITUMINOUS MATERIAL

- .1 The Contractor shall supply rollers in sufficient quantities, to produce a uniform, tight knit pavement surface having a minimum of 97% Marshall Density. The Contractor's compaction equipment shall include at least one self-propelled rubber tired roller, or a combination roller having a vibratory steel drum on one end and at least four pneumatic tires on the other end.

- .2 When compaction tests indicate that the density of the pavement is less than 97%, the Departmental Representative will require adjustments to production and compaction procedures in order to raise the density to the specified level.
- .3 When compaction tests indicate that the density of the pavement is less than 96% Marshall Density, the Contractor shall immediately provide and use the following minimum quantity of compaction equipment until the pavement has been constructed:
 - .1 For mixing plants with Manufacturers rated capacity of less than 320 tonnes per hour;
 - .1 2 steel vibratory breakdown rollers,
 - .2 1 self propelled pneumatic tired or combination intermediate roller,
 - .3 1 steel roller for final rolling.
 - .2 For mixing plants with Manufacturers rated capacity of greater than 320 tonnes per hour;
 - .1 2 steel vibratory breakdown rollers,
 - .2 2 self propelled pneumatic tired or combination intermediate rollers,
 - .3 1 steel roller for final rolling.
- .4 The distance between the two steel vibratory breakdown rollers shall not exceed 200m.
- .5 The Contractor shall use at least one steel vibratory roller, one pneumatic-tired or combination roller and one steel roller, when paving during the fall of the year at temperatures consistently below 10°C.
- .6 Rollers shall be in good condition and capable of reversing without backlash. They shall be operated in such a manner that all parts of the pavement receive equal compaction. The speed of the rollers shall not exceed 5km per hour and shall at all times be slow enough to avoid displacement of the material.
- .7 If the material tends to adhere to the rollers, they shall be kept moistened, but excess water or oil will not be permitted.
- .8 Rollers will not be permitted to park on the pavement during the rolling operation. They shall be parked off the newly constructed pavement when not in use or when being serviced. Rollers shall be moved to and from the pavement in such a way that the pavement edge is not damaged.
- .9 The rolling pattern established by the Contractor may vary depending on the gradation of the aggregate, the type of asphalt supplied and the type of rollers used.

3.12 JOINTS

- .1 Where transverse butt joints are required, the Contractor shall cut back the previously constructed lift to a vertical face.
- .2 Longitudinal seams and transverse joints shall be constructed so as to provide a smooth surface.

3.13 APPROVAL OF FINISHED SURFACE

- .1 The finished surface of each lift of bituminous pavement shall be smooth, free from segregation and roller marks, uniform and true to line and cross-section as shown on the plans or as specified by the Departmental Representative.

- .2 After final rolling, the surface profile will be measured with a profile measuring device approved for use by the Department.
- .3 Profile readings to determine smoothness on intermediate or bottom lifts of pavements can be provided at the Departmental Representative's or Contractor's request and will be dependent upon availability of the equipment. The Departmental Representative shall inform the Contractor of all readings.
- .4 Profiler readings will, if requested by the Contractor, be taken every second day during paving operations.
 - .1 Surface Tolerances
 - .1 Smoothness will be expressed in terms of a Profile Index which is the sum of the vertical deviations of the profile outside a 0mm blanking band, over a unit distance of 100m.
 - .2 The profile readings will be terminated 10m from the beginning and end of each bridge or railway crossing, 10m from an existing pavement which was placed under another contract, and 10m on either side of manhole covers/water valves.
 - .3 All bituminous pavements that are excluded from the profile index assessment will be subject to a review by the Departmental Representative. The review will be subjective and will be based on field conditions and workmanship. All mitigating measures shall be limited to correcting bumps or dips. Corrective actions shall be the responsibility of the Contractor.
 - .4 Any length of pavement at least 300m long and having a width of at least 3.5m will be considered a lane for the purpose of smoothness testing. This will include any passing, acceleration, deceleration, turning lanes that meet the above criteria.
 - .5 The Departmental Representative shall determine the final pavement profiles for inner and outer wheel path in each lane. PI calculations shall be based on the wheel path with the roughest values. A partial section resulting from an interruption of the continuous pavement surface is subject to the same evaluation as a whole section and pro-rated for 100m.
 - .2 Definitions
 - .1 Profile Index (PI₀): Roughness (mm/0.1km) above or below a 0mm blanking band.
 - .2 Bumps: Any deviations greater than 8mm or 12mm over a distance of 7.6m depending on the specification table being used for the contract. Any 100m section containing a bump(s) based on the table used is automatically disqualified from a PI bonus and will be subjected to a penalty per bump.
 - .3 Null Band: also known as the blanking band. It is a tolerance band projected on to the profile that represents a deviation from the best-fit line through the profile. This specification is based on a 0mm null band, and all roughness is included in the smoothness determination.
 - .4 Outer Wheel Path: a longitudinal line parallel to the centerline of pavement located approximately 0.9m to 1.1m from all lane edges.

- .5 Inner Wheel Path: a longitudinal line parallel to the centerline of pavement located approximately 1.5m to 1.8m from outer wheel path.
- .6 Section: a continuous 100m length of pavement
- .3 Riding Quality
 - .1 Corrective Actions
 - .1 Pavements require corrections when the Profile Index exceeds 80mm over 100m.
 - .2 All corrections must be completed within 1 calendar year of receiving notice of the final smoothness adjustment assessment, unless otherwise permitted by the Departmental Representative.
 - .3 Finished top lift pavement on which PI or bump values exceed the specified limits shall be corrected at the expense of the Contractor if so directed by the Departmental Representative. The corrections shall produce smoothness values no less than the specification range for both bump and PI values.
 - .4 The corrective methods used by the Contractor shall be applied to the full lane width. When completed, the corrected area shall have uniform texture and appearance, with the beginning and ending of the corrected area perpendicular to centerline of the paved surface.
 - .5 Any corrective methods proposed by the Contractor shall be subject to approval of the Departmental Representative. The Contractor shall not undertake any repair on any defective work prior to notifying the Departmental Representative. Any areas repaired prior to obtaining the Departmental Representative's approval will not be considered for penalty adjustment.
 - .6 The area repaired shall have a smooth transition to the surrounding pavement without negatively affecting any adjacent sections, impairing the functionality and/or structural characteristics or the service life of the area. The nature of the deficiencies shall be taken into account in the consideration of the method of repair.
 - .7 All corrective actions shall be performed at the Contractor's expense.
 - .8 The Departmental Representative will provide the profiler report and evaluation to the Contractor within 3 work days after any corrections are made.
 - .9 Asphalt cement required for corrective repairs will be supplied by the Contractor.
 - .10 Corrective actions may include: replacement of the lift, construction of a bituminous overlay, diamond grinding or other approved method.
 - .2 Removal and Replacement
 - .1 Should removal and replacement be proposed by the Contractor, following method shall be employed:

- .1 A saw shall be used to produce a vertical face along the boundary of the defective area or joint;
 - .2 Material within the sawn boundaries shall be removed to the full depth of the lift in such a manner that the vertical faces are not damaged;
 - .3 Tack coat shall be applied to both the horizontal and vertical faces;
 - .4 New bituminous material shall be placed and compacted to specification.
- .3 Diamond Grinding
- .1 Should removal and replacement be proposed by the Contractor, following method shall be employed:
 - .1 A saw shall be used to produce a vertical face along the boundary of the defective area or joint;
 - .2 Material within the sawn boundaries shall be removed to the full depth of the lift in such a manner that the vertical faces are not damaged;
 - .3 Tack coat shall be applied to both the horizontal and vertical faces;
 - .4 New bituminous material shall be placed and compacted to specification.
- .4 Appeals
- .1 The Contractor may appeal the measurements on any 100m section only once. The Contractor shall request the retest within 3 work days of receiving notice of the original assessment.

3.14 OPENING TO TRAFFIC

- .1 Unless otherwise specified, traffic will not be permitted on any newly paved surface until such time as the surface temperature has cooled to below 65°C.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 32 11 23 Aggregate Base Course
- .2 Specification 32 16 15 Concrete Walks, Curbs and Gutters
- .3 Specification 32 17 23 Pavement Markings

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .3 ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
 - .4 ASTM D1752 Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- .2 CSA Group
 - .1 CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA-A3000 Cementitious Materials Compendium.
 - .3 CSA G30.18 Carbon Steel Bars for Concrete Reinforcement.
 - .4 CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .3 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 830(I), Specifications for Concrete Pavement [March 2015]
 - .2 Manitoba Infrastructure and Transportation Construction Specification 930(I), Specifications for Aggregate for Portland Cement Concrete [March 2015]

1.3 DEFINITIONS

- .1 For purposes of this specification, the following definitions will apply:
 - .1 MIT-Scan-2 - is a magnetic imaging tool specifically developed for measuring dowel and tie bar alignments in concrete pavements and concrete bases.

- .2 Lot: A Lot is a portion of the work being considered for acceptance and is defined as the following:
 - .1 One day's plant production of more than four (4) hours where no change in the mix design has occurred. A change in mix design will require a new Lot designation.
 - .2 One day's plant production of less than 4 hours will be dealt with the Department Representative's approval, as follows:
 - .1 The material will be added to the previous day's Lot or next day's Lot if the mix design remains the same.
 - .2 If it is the last time the mix is produced with this mix design then the production will be designated as a Lot.
 - .3 If the Department Representative suspects a portion of a Lot is substandard, extra testing to define the area and severity of the deficiency shall be undertaken. A new Lot will be designated for this portion if this extra testing indicates the mix is subject to a Payment Adjustment or rejection.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: Company or person specializing Portland cement concrete paving
- .2 Certifications:
 - .1 Submit to Departmental Representative manufacturer's test data and certification that following material meets criteria and requirements of this section prior to starting concrete work:
 - .1 Portland Cement.
 - .2 Admixtures.
 - .3 Joint Sealants.
 - .4 Curing Materials.
 - .5 Joint Filler.
 - .2 Submit certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Sampling and Testing
 - .1 Prior to approval for use, proposed materials will be subject to inspection and/or testing by a qualified Testing Laboratory. When requested, the samples of materials shall be submitted at least 14 days before their intended use

- .2 The Department shall not be charged for the sampling of the materials submitted for testing.
 - .3 When agitating trucks are used to deliver concrete, the Contractor will collect samples at the point of delivery.
 - .4 When non-agitating trucks are used to deliver concrete, the Contractor will collect samples at the concrete batch plant and at the point of delivery. The Contractor shall provide a method of sampling from trucks at the batch plant that is acceptable to the Departmental Representative.
- .2 Submissions
- .1 Submit to Department Representative manufacturer's test data and certification that following material meets criteria and requirements of this section prior to starting concrete work:
 - .1 Portland Cement.
 - .2 Fly Ash.
 - .3 Admixtures.
 - .4 Joint Sealants.
 - .5 Curing Materials.
 - .6 Joint Filler.
 - .2 Submit certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.
 - .3 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures. Indicate VOC's:
 - .1 For cleaning and sealing compounds
 - .2 Sealing and caulking compounds
- .3 Cement
- .1 Cement for use in concrete shall meet the requirements of the latest edition of CSA Standard A3000.
- .4 Fly Ash
- .1 The contractor shall submit the mill certificate including chemical and physical composition and analysis, fly ash source and name of supplier. A new mill certificate shall be provided for each change of source of fly ash or when a new batch of fly ash is delivered. The certificate shall be produced prior to the start of production of concrete and approved by the Engineer.
 - .2 The mill certificate shall detail the following properties and the fly ash supplied shall meet the following properties:

Property Limits	Specified Limit
Fineness (% retained on 45µm	Max. 34%

Autoclave Expansion	0.8%
CaO %	8 – 20%
SiO2 %	Min. 50%
SO3 %	Max. 3%
Loss on Ignition	Max. 3%
Moisture Content	Max. 3%
Pozzolanic Strength	Min. 75% at 28 days

.5 Water

- .1 The water shall be free from injurious amount of oil, acid, organic matter, soluble chlorides, excess alkali, or other deleterious matter. All water for use in concrete shall be from a source which meets the requirements of the latest edition of AASHTO Specification M 157.

.6 Admixtures

- .1 Air-entraining admixtures shall conform to the requirements of ASTM C260.
- .2 Chemical admixtures shall conform to the requirements of ASTM C494 or ASTM C1017.
- .3 The Contractor is responsible for selecting the admixtures to be used. The Department will perform a mix design using the selected admixtures. If an acceptable mix design cannot be achieved using the admixtures selected, the Contractor shall select different admixtures.

.7 Aggregates

- .1 Aggregate for use in concrete shall meet the requirements of MIT Specification No. 930 "Specifications for Aggregate for Portland Cement Concrete".

.8 Steel

- .1 All steel in new concrete pavements shall be 'corrosion resistant steel' and shall meet the requirements of 'corrosion resistant steel' in the MIT's Approved Products List.

.9 Grouting Capsules

- .1 The Contractor shall supply and install anchoring grout capsules wherever existing concrete pavement or new concrete pavement must be drilled for the installation of load transfer dowels, deformed dowels, or deformed tie bars. The Contractor shall supply grout anchoring capsules in accordance with the MIT's Approved Products List. The grout anchoring capsules shall be installed according to the manufacturer's recommendations.
- .2 Tie bar and dowel bar holes shall be blown clean with compressed air before grouting
- .3 Excess grout shall be cleaned from the area surrounding the hole prior to curing.

.10 Dowel Bar Bond Breaker

- .1 Smooth load transfer dowels shall be thoroughly coated at the site with a thin uniform coating of an approved bond breaker for the length of the dowel. The bond breaker coating shall be smooth and free of voids. Bond breakers supplied by the Contractor shall be on MIT's Approved Product List
- .2 The Manufacturer of the dowel assemblies shall follow the product information sheet, noting the following:
 - .1 Dry film thickness shall be 0.85mm – 1.28mm;
 - .2 Prior to application, all surfaces shall be clean, dry, and free of rust, oil, and mill scale;
 - .3 The surface temperature of the dowels and the temperature of the Bond Breaker shall be between 10°C – 35°C at the time of application;
 - .4 Bond Breaker used for application shall be stored at temperatures between 10°C – 35°C at the time of application.
- .3 If in the opinion of the Departmental Representative the quality of the Bond Breaker is questionable, a “pull out” test AASHTO M253 will be performed and the maximum pull out load shall not exceed 11.2kN. Dowels failing this test shall be replaced or re-coated by the Contractor.
- .4 Prior to re-coating, all contaminants must be removed from the dowels and cure time shall be 24 hours. The same Bond Breaker material that was originally used to coat the dowels shall be used to re-coat them. Any dowels that require replacement or recoating shall be done at the Contractor's expense.

.11 Dowel Bar Assemblies

- .1 Dowel Bar assemblies shall be supplied in accordance with the MIT's Approved Products List and the Drawings

.12 Paving Plan

- .1 The Contractor shall furnish the following information in the Paving Plan:
 - .1 A detailed sequence and schedule of concrete placement operations including, but not limited to, width of pavement to be placed, proposed equipment, production rates, working hours, concrete hauling, placement, curing, and sawing methods. Identify backup equipment and the procedures that will be followed in the case of a breakdown of equipment.
 - .2 Detailed Quality Management Testing processes including test types, frequency, and integration of the MIT's Product Acceptance Testing. The Quality Control Plan should include the Contractor's proposed mitigative measures in the event that product quality is not achieved. A method to ensure the proper placement of

reinforcing steel, tie bars, and dowel bars as shown on the plan and details for placement of steel in plain doweled concrete pavement.

- .3 A traffic control plan that includes provisions for the placement and maintenance of barriers required to protect the concrete from traffic, for a minimum of 14 days after concrete placement.
- .4 Defined provisions for adequate lighting for all work done at night including finishing, curing, and joints sawing.
- .5 A method for ensuring concrete thickness is met.
- .6 Concrete consolidation procedure to be followed.
- .7 If forms are to be utilized, define the material, dimensions, type, connections, and staking of the forms.
- .8 Procedure for the protection of the fresh concrete from cold and hot weather.

.13 General Sampling and Testing Requirements

- .1 The Contractor shall submit all quality control results to the Department Representative.
- .2 The Contractor shall use Professional Engineering services and a qualified testing laboratory, licensed to practice in the Province of Manitoba, to assess, and where necessary, modify the materials/procedure to ensure the product meets all specifications requirements.
- .3 Quality management testing is the responsibility of the Contractor throughout every stage of the work from the crushing and production of aggregates to the final accepted product. Tests performed as acceptance testing will not be considered to be quality management tests. The Contractor shall provide and pay for equipment and qualified personnel, including all consulting services retained by it, to obtain all acceptance core samples and perform all quality management testing necessary to determine and monitor the characteristics of the materials produced and incorporated into the work, and the final product produced.
- .4 All quality management sampling and testing will be carried out in accordance with the Contractor's QMS and construction specifications.
- .5 Quality management measures, as outlined in the QMS, shall be followed to ensure the pavement design and acceptance criteria is being achieved. Results of all quality management tests shall be submitted to the Department Representative as they become available.
- .6 The Department Representative may require an increase in the frequency of any quality management test to ensure consistency and the desired quality of the materials or products. The Contractor shall arrange and pay for any additional tests required by the Department Representative.
- .7 All costs associated with pavement coring for both quality management and acceptance testing shall be the responsibility of the Contractor.

- .8 The Contractor shall be responsible for the costs of all acceptance testing performed on the initial works and on material that is used to replace material that has been previously rejected.
- .9 The Contractor shall repair all core holes or other sampling disturbances, as required for either quality management or acceptance testing to a uniform smooth surface condition, using fresh concrete material.
- .10 The Contractor shall use a MIT-Scan-2 which is manufactured by MIT GmbH to scan the dowel and tie bars. The Contractor shall ensure that the surface to be tested is clear and free of any loose stone or other debris. To facilitate data analysis, all joints shall be scanned with the MIT-Scan-2 moving in the same direction. For each joint, dowel bars shall be numbered consecutively beginning with the number "1". All measurements shall be reported in reference to the top surface of the concrete.
- .11 One week prior to the commencement of the concrete paving operation, the Contractor shall submit to the Department Representative documentation stating the following:
 - .1 The MIT-Scan-2 has been properly calibrated for the size of dowel bar and tie bar to be used in the Contract;
 - .2 The manufacturer's specified measurement tolerances and that the MIT-Scan-2 is operating within the manufacture's tolerances;
 - .3 The serial number of the MIT-Scan-2 to be used; and
 - .4 The MIT Scan-2 is capable of producing a printout from the on-board printer for every joint scanned, immediately following the scan.
- .12 The Contractor shall submit to the Department Representative a copy of the printouts produced from the onboard printer of the MIT-Scan-2 for every joint scanned, at the end of each day's production and upon request. All printouts shall remain the property of the Department Representative.
- .13 For each week of production, the Contractor shall prepare a report from the measurements obtained. A hard copy of the report along with the electronic version of the data in Excel format shall be submitted to the Department Representative within three business days of completing each trial section and at the start of each working week during production.
- .14 The report shall consist of the following:
 - .1 Contract number, date, highway number, and direction of traffic;
 - .2 Joint number, lane number, station, and the direction of scanning;
 - .3 Bar number and x-location of the dowel bar;
 - .4 Horizontal and vertical misalignment in mm;
 - .5 Side shift in mm;
 - .6 Depth to center of the dowel bars in mm; and
 - .7 All out-of-tolerance readings shall be highlighted in red.

- .15 The Contractor shall use the MIT-Scan-2 to verify the position and alignment of the dowel bars and tie bars within the trial section and during production in the presence of the Department Representative.
 - .16 When dowel/tie bar assemblies are used, the MIT-Scan-2 data shall be collected for information purposes to select joint cut-outs and to identify dowel bars and tie bars that are acceptable with pay adjustment and rejectable. For automatic dowel and tie bar inserters, the MIT-Scan-2 data shall be collected for the selection of joint cut-outs, for identifying dowel and tie bars that are acceptable with pay adjustment and rejectable.
 - .17 After all acceptance tests for the Lot are reported to the Department Representative, the Department Representative may provide the Contractor with a copy of the results of acceptance tests within one working day of their availability. If the results are not submitted to the Department Representative within five working days after the completion of the scan of each individual lot, the Department Representative will have the option to engage an independent Department Representative to perform MIT Scan and data analysis, and then recover the cost from the contractor.
- .14 Test Methods
- .1 An outline of the quality control tests is as follows:
 - .1 The contractor shall be responsible for all aspects of sampling and testing the plastic concrete mix for slump, density, air content, and temperature in accordance with CSA A23.2.
 - .2 The minimum frequency shall be one test from each load of concrete until satisfactory control is established. Satisfactory control is established when tests on five consecutive loads leaving the mixing plant and the same five consecutive loads at placement are within the contract requirements with no adjustments required. After satisfactory control has been established, testing shall be carried out on every fifth load leaving the plant fifth and the same load at placement. If testing indicates that a load does not meet the requirements, that load shall be rejected and testing shall resume on each load until satisfactory control is established. The Department Representative may consider relaxing this testing requirement provided the Contractor is able to demonstrate consistent and satisfactory control.
 - .3 Samples of concrete for slump, density, air content, and strength tests shall be taken in accordance with CSA A23 .2, Sampling Plastic Concrete.
 - .4 Slump tests shall be made in accordance with CSA A23 .2, slump of concrete. If the measured slump falls outside the limits specified in section 2.2.2 Mix Proportion of this specification, a second test

shall be made. If the second test falls outside the limit, the concrete represented by the test sample shall be rejected.

- .5 Air content determinations shall be made in accordance with CSA A23 .2, 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 that the second test falls outside the specified limit, the volume of concrete represented by the test sample shall be rejected.
 - .6 Density of plastic concrete shall be tested in accordance with CSA A23 .2-6C Density, yield, and cementing materials factor of plastic concrete.
 - .7 Test specimens for the strength testing shall be made and cured in accordance with CSA A23.3, Making and Curing Concrete Compression and Flexure Test Specimens.
 - .8 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 production.
 - .9 In the event that compressive strength is not achieved, cost of additional testing including core removal, core testing, and repair of core holes shall be paid for by the contractor.
- .15 Verification of Dowel and Tie Bar Alignment During Production
- .1 The Contractor shall measure the position and alignment of the dowel bars of every 10th transverse joint and of the tie bars of every 10th panel using the MIT-Scan-2, in the presence of the Department Representative.
 - .2 If the position or alignment of any dowel bar or tie bar is found to be out of acceptance(tolerance) limits, scanning of the adjacent joints will be required. The Contractor shall scan adjacent joints until five consecutive joints on each side are found with all dowel and tie bars within tolerance. If inconsistency in the placement of the dowel bars or tie bars becomes evident, the Contractor shall scan 100% of the joints until dowel bar placement becomes consistent.
 - .3 Out of acceptance (tolerance) refers to a value outside the accepted with full payment limit.
 - .4 Evaluation of dowel bar alignment shall be carried out within 24 hours of concrete placement.
- .16 Acceptance Sampling and Testing
- .1 The Department Representative will take samples and carry out testing and inspection of the workmanship and materials incorporated or being

incorporated into the work in order to ensure compliance with the specifications requirements. The Contractor shall cooperate with the Department Representative for such sampling, testing, and inspection. Such inspection shall not relieve the Contractor from any obligation to perform all the work strictly in accordance with the specifications requirements.

- .2 Where it is required in the specifications that the Contractor shall submit samples of materials or mixtures to the Department Representative for acceptance, these samples shall be submitted in sufficient time for proper testing.
- .3 Where specified, random sampling procedures shall be followed, and where no specific random sampling procedure is specified, the sampling procedure shall be as identified by the Department Representative in the case of acceptance testing and by the Contractor in the case of quality management testing.
- .4 The Department Representative shall have access to the work at all times for taking samples. The Contractor shall provide any assistance necessary for taking samples and shall reinstate pavement layers or other structures to the satisfaction of the Department Representative at the positions where samples have been taken. No separate compensation for providing assistance with sampling and for reinstatement where samples are taken will be made.
- .5 The Contractor shall provide sampling stands, sampling devices, and other facilities, which the Department Representative may require to safely obtain representative samples of the item being produced.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage of materials shall be in accordance with the requirements of CSA-A23.1, Clause 9, Storage of Materials, except as otherwise specified herein.

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Mix design requirements:
 - .1 Submit concrete mix design to Departmental Representative for approval 2 weeks prior to commencing work.
- .2 Mix Proportions
 - .1 The use of fly ash in the concrete mix will be permitted. The Contractor will have the option to replace cement up to but not exceeding the

following limits, by weight of total cementitious materials, depending on the type of cement used in the concrete. The types of cement shall be in accordance with the following table:

.2

Type of Cement	Maximum Amount of Fly Ash Permitted
GU: General use of Hydraulic Cement	20%
MS or HS: Moderate or High Sulphate-resistant hydraulic cement	20%
HE: High Early strength hydraulic cement	0%
MH or LH: Moderate or Low Heat of hydration cement	0%

- .3 The use of Fly ash will not be permitted when ambient temperature during placing is below 0°C or is expected to be below 0°C within 3 days of placement.
- .4 Before concrete mixing starts, the proportions of cement, fly ash, water, fine and coarse a
- .5 Aggregates and admixtures that are to be used in the concrete, will be determined by the Department. The mix design will be based on the test results of the samples previously tested and approved for concrete. The mix proportions will be based on the concrete meeting the following physical requirements:

Cement Requirements	
Type of Mix	Minimum Cementitious Content
Normal	340kg/m³
Cold Weather or Early Strength	355kg/m³

Concrete Physical Requirements	
Air Content (at delivery point)	6 – 8%
Slump	± 25mm from design slump
Minimum 28 Day Strength	32MPa
Max. Water / Cement Ratio	0.40

- .6 Minimum air behind the paver is 4.5%. The Contractor shall adjust the air content, at delivery, to maintain the minimum air behind the paver at all times.

- .7 The Contractor shall select a design slump for each concrete mix used on a project. The Department will provide a mix design to achieve the requested slump.
- .3 Aggregate Samples
 - .1 During aggregate production, the Contractor shall provide sufficient quantities of fine and coarse aggregate samples for concrete mix designs.
- .4 Mix Design Changes
 - .1 Changes to the mix design shall not be made without the Departmental Representative's approval

2.2 MATERIALS

- .1 General

The Contractor shall be responsible for the supply, safe storage, and handling of the following materials:

 - .1 Concrete Constituent Materials
 - .1 Portland Cement
 - .2 Aggregates
 - .3 Water
 - .4 Air-entraining Admixtures
 - .5 Other Admixtures
 - .6 Fly Ash
 - .2 Reinforcing Steel (includes dowels, tie bars, dowel assemblies, tie bar chairs or assemblies and, other accessories)
 - .3 Liquid, Membrane-Forming, Curing Compound
 - .4 Bond Breaking Lubricant for Coating Smooth Dowels
 - .5 Expansion Joint Filler

All materials to be used must be on the MIT Approved Products List (APL). All materials shall be applied in strict accordance with the manufacturer's recommendations.
- .2 Portland Cement
 - .1 The Contractor shall supply Type GU Portland cement meeting the requirements of the latest version of Canadian Standard Association A3001 Cementitious Materials for Use in Concrete. Unless otherwise approved by the Department Representative, the specification requirements shall apply to the Portland cement in the delivery vehicle at the Portland cement storage site.
 - .2 The Contractor shall, to the satisfaction of the Department Representative; prevent contamination of the Portland cement, by Portland cement of another type or by any other material; maintain records of times Portland

- cement storage site, and start and completion of receipt of Portland cement delivery orders, cement departure from the source, arrival at the unloading, and provide this information to the Department Representative upon request. Fly ash blended Portland cement will be permitted. No other blended cement will be permitted.
- .3 The Contractor shall provide the Department Representative with a Certificate of Compliance acceptable to the Department Representative, for the Portland cement to be used in the work.
 - .4 Sampling and testing for the purpose of quality management shall be performed in accordance with the Contractor's Paving Plan. The Contractor shall submit a Portland cement test results in accordance with CSA A3001 14 days prior to paving.
 - .5 The Department Representative may verify the quality of the material at any time. Sampling and testing for verification purposes will be in accordance with the latest version of CSA A3001. Sampling and testing for acceptance shall be done by an independent laboratory. The Contractor shall be responsible for all costs associated with sampling and testing. The Contractor shall submit all test results to the Department Representative.
 - .6 Product not meeting the latest version of CSA A3001 will not be accepted.
- .3 Aggregates
- .1 Aggregate production and stockpiling shall meet the requirements of MIT Specification No. 930 "Specifications for Aggregate for Portland Cement Concrete".
- .4 Water
- .1 Mixing and curing water shall be supplied by the Contractor.
 - .2 Water shall conform to the requirements of the latest version of CSA Standard A23 .1.
- .5 Air-Entraining Admixtures
- .1 Air-entraining admixtures shall be supplied by the Contractor.
 - .2 Air-entraining admixtures shall conform to the requirements ASTM C260 and be on MIT's Approved Products List.
- .6 Other Admixtures
- .1 All accepted admixtures, such as water reducing agents and superplasticizers, shall conform to ASTM C494, be on MIT's Approved Products List, and be compatible with all other constituents. The addition of calcium chloride, accelerators, and air-reducing agents will not be permitted, except when accepted by the Department Representative. Retarders or set controlling admixtures may be used for concrete specified with corrosion inhibitor.
- .7 Fly Ash

- .1 If fly ash is used, the Contractor shall submit the mill certificate including chemical and physical composition and analysis, fly ash source, and name of supplier. A new mill certificate shall be provided for each change of source of fly ash or when a new batch of fly ash is delivered. The certificate shall be produced prior to the start of production of concrete and approved by the Department Representative.
- .2 The mill certificate shall detail the following properties and the fly ash supplied shall meet the requirements specified in Section 2.4 of MIT Spec 830(I).
- .8 Reinforcing ap
 - .1 Dowels and tie-bars shall be in accordance with Section 2.8, 2.9, 2.10 and 2.11 of MIT Spec No.830(I).
 - .2 Dowels: clean, straight and free from flattened or burred ends, plain round bars of grade 300 or better conforming to CSA G40.20 and be corrosion resistant.
 - .3 Tie-Bars: deformed steel bars in compliance with CSA G30.18 and be corrosion resistant.
- .9 Curing Compound
 - .1 Curing compound: to ASTM C309, Type 1-D or 2.
- .10 Expansion Joint Filler
 - .1 Prefomed expansion joint filler: to ASTM D1752.
- .11 Protective covers and insulation for cold weather concreting:
 - .1 Shall be in compliance with CSA A23.1/A23.2.

2.3 DESIGN REQUIREMENTS

- .1 Responsibility for Mix Design
 - .1 Preparation and submission of concrete mix design(s) for the Departmental Representative verification and acceptance are the responsibility of the Contractor. The Contractor shall use Professional Engineering services and a qualified testing laboratory licensed to practice in the Province of Manitoba to assess the aggregate materials proposed for use and to carry out the design of the concrete mixes. The design testing laboratory shall have obtained pre-qualification status from the MIT and have received a CSA Category II registration.
 - .2 All costs incurred in mix design formulation are the responsibility of the Contractor. Shipping costs for samples sent to the Department Representative for verification and approval are the responsibility of the Contractor.
- .2 Mix Proportions

- .1 Before concrete mixing starts, the proportions of cement, water, fine and coarse aggregates, and admixtures that are to be used in the concrete, will be determined by the Contractor and submitted to the Department Representative for approval. The mix design will be based on the test results of the samples previously tested and approved for concrete. A concrete mix shall have the following properties when tested in accordance with the requirements of CSA A23.1 and CSA A23.2 as shown in Table 1 below:

Table 1: Concrete Mix Properties

Type of Concrete Mix	Total Cementitious Content (minimum kg/m ³)	Air Content (%)	Slump (mm)	28 Day Comp. Strength (Mpa)	Maximum Water/Cementitious Material Ratio
Normal	340 kg/m ³	6-8	30-80	32	0.40
Cold Weather or Early Strength	340 kg/m ³	6-8	30-80	32	0.40
Optimized Gradation (Tarantula Curve)	Paste/void ratio 1.25 to 1.75 and 280 kg/m ³	6-8	30-80	32	0.40

- .2 The density of the supplied fresh concrete mix shall be within ± 50 kg/m³ of the approved mix design.
- .3 The contractor shall prepare and submit the concrete mix design at least 14 days before the first placement of the concrete for review and approval by the Department Representative.
- .4 An increase to the water/cement ratio will not be permitted. No additional payment will be made for additional mixtures.
- .5 The use of fly ash in the concrete mix will be permitted with the following limitations:
- .1 The replacement of Portland cement with the fly ash shall not exceed 20% by weight of total cementitious materials
 - .2 The use of fly ash will not be permitted when ambient air temperatures during concrete placing is below 0°C or is expected to be below 0°C within three (3) days of placement.
- .6 The Portland cement concrete shall meet all the requirements of CSA Standard A23.1. For CSA A23.1 Section 4.4.4.2, Air Content of Hardened Concrete, the confirmation of the air-void system shall be on drilled cores obtained from the in-place concrete or on cylinders made from the concrete mix.

- .7 Concrete mixes that will be placed by concrete pump, shall be designed for pumping.
- .8 If, during the progress of the work, it is determined that the concrete has inadequate workability, or does not meet the Specifications requirements, the Contractor shall provide a new mix design for the Department Representative's approval, in accordance with the foregoing requirements.
- .9 The sampling and testing of aggregates and the concrete mix design shall be completed by a CSA certified, ISO 17025 (Standards Council of Canada) or CCIL certified laboratory that has a permit to practice in the Province of Manitoba. The testing laboratory shall provide an engineering opinion that concrete aggregate and mix designs are suitable for the intended use and are expected to perform to specified standards.
- .10 All costs associated with aggregate testing and providing the mix designs shall be the responsibility of the Contractor.
- .11 Supporting documentation for each concrete mix design shall consist of materials used, sources, and mix proportions and the test data demonstrating compliance with the requirements of the Contract for the following:
 - .1 Air void system parameters of the hardened concrete;
 - .2 Aggregate test results;
 - .3 Admixture test results;
 - .4 Water test results, if water other than municipal drinking water is used.
 - .5 Minimum specified 28-Day compressive strength; and
 - .6 Any other specific Contract requirements.
- .12 In addition, the Contractor shall supply the following documentation:
 - .1 Currently valid Certificate of Ready Mixed Concrete Production Facilities as issued by the Manitoba Ready Mixed Concrete Association (MRMCA) for any plant being used;
 - .2 Names of suppliers and sources for aggregates, cement, and fly ash;
 - .3 Test reports for the cement and fly ash that are representative of the materials to be used during concrete production;
 - .4 A minimum of five sets of concrete compressive strength tests for the hand placement paving mix with and without fly ash and the sidewalk mix with and without fly ash to demonstrate that the concrete mix will achieve the required strength. The strength test data must be obtained from trial batches;
 - .5 Certificate of compatibility between different admixtures;
 - .6 When non-agitating trucks are used, the cement shall be certified as being free from early stiffening tendencies when tested according to CAN/CSA A3004-B6; and

- .7 The range of concrete production rates required for the work.
- .3 Mix Design Changes
 - .1 Changes to the mix design shall not be made without the approval of the Department Representative.

Part 3 Execution

3.1 EXAMINATION

- .1 Inform Department Representative of unacceptable conditions immediately upon discovery.
- .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Department Representative.

3.2 EQUIPMENT

- .1 Slip Form Paver
 - .1 The equipment shall consist of a slip form paver and any additional equipment that is required to construct a stable and rigid pavement, which meets the specified widths, depths, crown, alignments and grades.
 - .2 For pavement widths between 5.0m and 8.6m, the slip form paver shall have a minimum manufacturer rating for gross weight of 25 000kg and an engine having a minimum power output of 150kW.
 - .3 For pavement widths less than 5.0m, the slip form paver shall have a minimum manufacturer rating for gross weight of 15 000kg and an engine having a minimum power output of 100kW.
- .2 Automatic Fine Trimming Machine
 - .1 The machine used for automatic fine trimming of the granular base course shall be capable of trimming the base to the design specifications.
- .3 Mixing Plant
 - .1 Commercial ready-mixed concrete plants and batch plants supplying Portland cement concrete under this specification shall be certified in accordance with the Manitoba Ready Mix Concrete Association's Certification of Ready Mixed Concrete Production Facilities. Proof of the certification shall be submitted with the mix design statement.
 - .2 The concrete plant shall proportion the cement and fine and coarse aggregates by mass. The plant shall have separate bins or compartments for the cement, fly ash and for each type and size of aggregate. They shall be designed to prevent intermingling of different materials, contamination, segregation, breakage, and allow free movement of materials to the discharge openings.

- .3 Water and liquid admixtures shall be proportioned by volume or mass. If water is to be measured by volume, the device shall be so arranged that variable pressure in the water supply line does not affect the measurements. The device shall be fitted with the necessary valves and connections to divert the water measured for a batch so that the accuracy of measurement can be easily verified.
 - .4 The dispensing equipment for adding the liquid admixtures shall be automated and shall also have visual, volumetric measuring or read-out units. Pressure systems shall have a safety check valve to prevent admixtures from re-entering the read-out units before the discharge of the admixture to the present batch.
 - .5 The Contractor shall supply and install filters, dust collectors or other equipment to minimize any loss or damage to the cement.
 - .6 Weighing devices in the plant shall be tested and their accuracy approved before the construction starts and may be tested with standard weights at any time. Scales shall be designed and maintained to within 0.5% accuracy through the normal operating range for cement, water and aggregates. Minimum increments on the scale or digital readout shall not exceed 2kg for the cement scale and 10kg for the aggregate scale. The weighing beam, dial, or digital readout shall be placed in full view of the operator during the operation of the gate, which delivers the material to the hopper. Adjustments to the weighing devices shall not be made without the Departmental Representative's approval.
- .4 Mixers and Agitators
- .1 Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers or truck agitators. Each mixer or agitator shall have the manufacturer's rating plate(s) attached to it in a prominent place indicating
 - .1 the gross volume of the drum or container
 - .2 the rated maximum mixing capacity, measured by volume;
 - .3 the rated maximum agitating capacity;
 - .4 the maximum and minimum mixing and agitating speeds for the drum, blades or paddles.
 - .2 When stationary mixers are used for the complete mixing of concrete, the time of discharge shall be controlled by an acceptable timing device that prevents discharge of the batch until the specified mixing time has elapsed.
 - .3 Mixers and agitator trucks shall be operated within the limits specified on the equipment manufacturer's rating plates.
 - .4 To ensure that the mixers and agitators are producing concrete uniform in consistency throughout the batch, "within-batch" uniformity tests may be made on selected batches. Individual samples,

at approximately the beginning, the mid-point, and the end of the load, will be obtained and tested for uniformity of the slump.

.5 If the slump of the 3 individual samples varies by more than 30mm, then the mixer or agitator shall not be used until the condition is corrected.

.6 Accumulation of hard concrete or mortar within the mixer will not be permitted.

.5 Side Forms

.1 The side forms shall be constructed of steel for all concrete pavements. Forms shall be rigid, straight and true with a smooth face and have locked joints. For every 3m form section, a minimum of 3 pins shall be used for securing the forms to the base.

.2 Forms for curves shall be capable of installation to within 12mm of the true curve. If the radius is less than 50m, forms shall be either flexible material or custom-shaped to fit the curve. The forms shall be designed to be securely fastened together in the correct position.

.3 The forms shall be clean and free of hardened concrete.

.6 Screed

.1 The Contractor shall provide a mechanical screed and a back up manual screed to accommodate a breakdown.

.2 The manual screed will only be permitted to screed concrete already mixed and placed on grade at the time of the mechanical screed's breakdown. Further paving shall stop until the mechanical screed is again operative.

.7 Brooms

.1 When required, the Contractor shall provide a mechanical broom. At least 2 hand brooms will be on site to accommodate a breakdown. Each hand broom shall be approximately 600mm wide with at least 3 rows of bassine fibres not more than 112mm long. The brooms shall have handles long enough to permit the brooming of one lane of pavement.

.8 Spraying Device

.1 The Contractor shall provide a mechanical sprayer for applying the liquid, curing compound to the surface and sides of the pavement. To accommodate a breakdown, the Contractor shall provide portable, pressurized, spray containers capable of completing the application as soon as the finishing is completed.

.9 Portable Vibrator

.1 The Contractor shall provide a portable vibrator, with its own power unit, to operate at a uniform, minimum 3 600 impulses per minute.

.10 Asphalt Kettle

- .1 The Contractor shall provide thermostatically controlled heating equipment for the joint sealant used. The heating equipment shall meet the requirements specified by the joint sealant manufacturer.

.11 Additional Equipment

- .1 The Contractor shall also provide foot bridges, edgers, small tools and other equipment necessary to complete the work in accordance with these specifications.

3.3 FORMWORK

.1 Install in accordance with following requirements:

.1 For fixed form paving:

- .1 Provide forms of sufficient strength to support and keep alignment under weight of spreading and finishing machines.
- .2 Set forms true to line and grade, join neatly and tightly and stake securely to resist concrete pressure and impact from tampers without springing.
- .3 Clean and oil forms before each use.
- .4 Obtain Departmental Representative's approval of forms before placing concrete.

.2 For slip form paving:

- .1 Provide sufficient length of slip form trailing behind paver to prevent slumping at slab edge. Ensure rigid lateral support.
- .2 Set grade and line for control string or wire.

3.4 SUBGRADE, SUBBASE AND BASE PREPARATION

- .1 Soft, yielding materials or other portions of subgrade that will not compact to specification shall be removed and replaced with suitable material. Subgrade to be brought to a firm unyielding condition with a uniform density. It shall be compacted at or above optimum moisture content to 95% Standard Proctor density.
- .2 Subbase and base to consist of specified material and have a compacted thickness of not less than specified.
- .3 For slip-form paving, base travelled by tracks in paving machine shall be firm and have a smooth surface.
- .4 Subbase and base shall be compacted to specified density.
- .5 Prepared subbase and base shall be checked for conformity with the cross-section and grade tolerances. Finished surface of subbase shall not deviate more than 10 mm above and 20 mm below specified grade and cross-section, and surface shall not deviate more than 10 mm at any place on a 3 mm template.

- .6 Repair damage to subbase and base resulting from hauling or equipment operations.
- .7 Prior to placing concrete, base shall be thoroughly wetted. Wetting shall be carried out, such that standing water is not present on grade.
- .8 For main-lane pavements, the Contractor shall use a fine grading trimmer machine to bring the base to the design elevations before placing the concrete. All depressions greater than 15mm shall be filled to the design elevation and thoroughly compacted.
- .9 If the concrete placement will be delayed more than 48 hours or more, the Contractor shall water the base and apply a prime coat at a rate of 0.6 L/m² and allow to cure. If the concrete placement follows the fine grading immediately, the base shall be sufficiently watered to avoid water suction from the freshly placed concrete.
- .10 There shall be no pools of water on the base prior to placing concrete. Concrete shall not be placed on a wet, soft, or frozen base.
- .11 Surface condition of base to be approved by Department Representative before placing concrete.

3.5 SETTING SIDE FORMS

- .1 Side forms, shall be set to exact grade and alignment ahead of placing the concrete. The side forms shall be set on a minimum 450 mm wide and a maximum 15 mm deep sand or granular base course cushion. The cushion shall be placed on a stable and well-compacted foundation.
- .2 Form sections shall be tightly joined by a locked joint, free from play or movement in any direction. They shall be staked with a minimum of 3 steel pins for each 3-metre section. A pin shall be placed at each side of every joint.
- .3 Staked forms shall be securely set to withstand deflection from the impact and vibration of the consolidating and finishing equipment. The forms shall not deflect more than 6 mm when tested with a load equal to the loads exerted by the consolidating and finishing equipment.
- .4 Before placing the concrete, the forms shall be cleaned and coated with a form release agent.

3.6 REINFORCING STEEL AND DOWELS

- .1 Place sufficient number of joint dowel assemblies in advance of paver to avoid delay in concrete placement.
- .2 Remove oil, grease, dirt and deleterious material from reinforcing bars before placing concrete.
- .3 All reinforcing steel shall be placed in accordance with the details shown on the drawings. Steel placement has to be approved by Department Representative before placing concrete.

- .4 Dowel bar assemblies shall be used for placing dowel bar reinforcing steel in concrete pavement.
- .5 An automatic tie bar inserter or tie bar assemblies or tie bar chairs shall be used for placing tie bar reinforcing steel in concrete pavement.
- .6 When tie bar inserter are used, they shall be capable of automatically setting tie bars at mid-depth of the concrete, centered on the longitudinal joint as specified in this section. Insertion of the bars shall be fully computerized for the depth and spacing.
- .7 The equipment shall be capable of consolidating the concrete around the bars.
- .8 When dowel bar and/or tie bar assemblies are used, they shall be rigidly fabricated and fastened to the base to hold the dowels horizontally and vertically in alignment until the concrete is placed and finished.
- .9 Thickness allowance for loss due to diamond grinding shall not be considered as part of the design thickness to determine the mid depth for steel placement.
- .10 Reinforcing steel for dowel and tie bars shall be straight and free from distortion. It shall be kept clean and free from rust and form release agents.
- .11 Plain round dowels shall be placed at all transverse contraction joints. The dowels shall be aligned parallel to the centreline and the slab surface within the specified tolerances. Dowels shall be placed at intervals as shown on the Drawings. The plain round dowel reinforcing steel shall be uniformly coated with a bond breaker.
- .12 The Contractor will mark the location of the dowels on the top of the forms or on the grade so the transverse joint can be accurately marked and cut. Transverse contraction joints must be continued on adjacent tapers, lanes, or ramps with appropriate reinforcing steel
- .13 Where continual concrete pouring is interrupted, a construction joint shall be formed at mid panel and deformed dowels shall be used. The dowels shall be aligned parallel to the centerline and the slab surface within the specified tolerances. The deformed dowels shall be placed at 300 mm intervals from centre to centre. The deformed dowels shall be placed at a minimum of 100 mm but no more than 200 mm away from any longitudinal joint and outer edges of concrete
- .14 Where deformed dowels are required on longitudinal joints for adjacent tapers and ramps, the Contractor shall either insert the dowels in the plastic concrete or drill holes in the hardened concrete and anchor the deformed dowels with grout anchoring capsules. The deformed dowels shall be placed at 600 mm intervals from centre to centre. The deformed dowels shall be placed at a minimum of 100 mm but no more than 200 mm away from the terminus of the longitudinal joint and outer edges of concrete.
- .15 Deformed tie bars at main lanes (centreline) longitudinal joint shall be spaced 750 mm from centre to centre. No tie bars shall be placed within 750 mm of the transverse contraction joints. For horizontal curve with a radius less than 500 metres, and for acceleration and deceleration lanes, tie bars spacing shall be 600

mm from centre to centre and no tie bars shall be placed within 750 mm of the transverse contraction joints.

- .16 No tie bars shall be placed within 750 mm of the transverse contraction joints.
- .17 The Contractor shall supply and install anchoring grout capsules wherever existing concrete pavement or new concrete pavement must be drilled for the installation of load transfer dowels, deformed dowels, or deformed tie bars. The grout anchoring capsule must be an approved product on the MIT's Approved Products List (APL). The grout anchoring capsules shall be installed according to the manufacturer's recommendations. Tie bar and dowel bar holes shall be blown clean with compressed air before grouting. Excess grout shall be cleaned from the area surrounding the hole prior to curing.
- .18 Load Transfer Dowel Bar Tolerances
 - .1 Load transfer dowel bars shall be installed at mid-depth of the concrete slab, in a plane with the pavement surface and parallel to the centreline of the road. The tolerance for placement of dowel bars shall be as noted below (all measurements are taken from the centre of the bar cross section), vertical longitudinal and transverse translations are measured at the theoretical centre of the dowel bar (at the centerline of the transverse joint):
 - .1 Vertical tilt over the full length of the dowel bar (measured from the ends of the dowel) shall not exceed 15 mm;
 - .2 Horizontal skew over the full length of the dowel bar (measured from the ends of the dowel) shall not exceed 15 mm;
 - .3 Vertical translation (depth) is the difference in the actual dowel bar location from the theoretical mid depth of the slab;
 - .4 Tie bar tolerances shall be as per Table 2 below.

Table 2: Load Transfer Dowel Bar Vertical Tolerances

Design Thickness (mm)	Vertical Tolerance above the theoretical mid depth (mm)	Vertical Tolerance below the theoretical mid depth (mm)
200	6	10
225	10	15
250	12	20
275	12	25

- .5 Thickness allowance for texturing of hardened concrete with diamond grinding shall not be considered part of the design thickness to determine the depth of load transfer dowel bars.
- .6 Longitudinal translation (longitudinal side shift) of the dowel bar shall not exceed 50mm.

.7 Transverse translation (transverse side shift) of the dowel bar shall not exceed 50 mm.

.19 Tie Bar Tolerances

- .1 Tie bars shall be installed at mid-depth of the concrete slab, in plane with the pavement surface and perpendicular to the centreline of the road. The tolerance for placement of tie bars shall be as noted below (all measurements are taken from the centre of the bar cross section), vertical longitudinal and transverse translations are measured at the theoretical centre of the dowel bar (at the centerline of the transverse joint);
 - .1 Vertical tilt over the full length of the tie bar (measured from the ends of the tie bar) shall not exceed 50 mm;
 - .2 Horizontal skew over the full length of the tie bar (measured from the ends of the tie bar) shall not exceed 100 mm;
 - .3 Vertical translation (depth) is the difference in the actual tie bar location from the theoretical mid depth of the slab.
- .2 Tie bar tolerances shall be as per Table 3 below.

Table 3: Tie Bar Vertical Tolerances

Design Thickness (mm)	Vertical Tolerance above the theoretical mid depth (mm)	Vertical Tolerance below the theoretical mid depth (mm)
200	6	10
225	10	15
250	12	20
275	12	25

3.7 BOND BREAKER

- .1 Concrete dowel bond breaker must be used on plain round dowels installed at contraction joints in concrete pavements or appurtenances.
- .2 The bond breaker must be an approved product from the MIT's Approved Products List (APL). If the concrete dowel bond breaker is not already on the MIT's (APL), approval for its use may be considered by submission of a representative sample along with product technical data for evaluation by the Departmental Representative.
- .3 Each dowel shall be completely coated with an approved bond breaker. The bond breaker shall be shop applied or field applied in accordance with the Manufacturer's recommendations.
- .4 Dowels which are not covered in concrete within six months of the date of application for shop applied or within six months of the date of application for

field applied shall be re-coated with the same product originally applied prior to concrete cover. All contaminates shall be removed from the dowels prior to recoating. The Manufacturer's minimum cure time shall be followed. Field re-application will be required any time if the bond breaker is lost.

3.8 BATCHING CONCRETE

- .1 The concrete mixes shall be batched in accordance with the mix design.
- .2 The weight of aggregates and cement from the proportioning plant shall be within 0.5% of the designated batch weights. The batch weights may be adjusted to allow for moisture variations in the aggregates.

3.9 MIXING AND DELIVERING CONCRETE

- .1 The plastic concrete shall be produced as a uniform mixture free of lumps and segregation, and shall have consistent air content and slump throughout each load. The plastic air content and slump shall meet the Specifications Requirements. The concrete temperature at the time of discharge from the truck shall be at or between 10°C and 28°C.
- .2 Concrete shall be mixed and transported to the point of delivery by one of the following combinations;
 - .1 Mixed completely in a stationary mixer and transported to the point of delivery in a truck mixer operating at agitator speeds;
 - .2 Mixed completely at a batch plant and transported to the point of delivery by the use of non-agitating equipment;
 - .3 Mixed completely in a truck mixer at the batch plant and transported to the point of delivery operating at agitator speeds; or
 - .4 Mixed completely in a truck mixer at the point of delivery after the addition of mixing water.
- .3 The minimum mixing time for concrete shall be as recommended by the equipment manufacturer or the minimum time required to produce concrete meeting the requirements of this Contract, whichever is greater.
- .4 Concrete that is transported in non-agitating equipment shall be covered.
- .5 The Contractor shall ensure that delivery shall be made by smooth roads to minimize segregation during transport.
- .6 The body of the container used for the delivery of non-agitated concrete shall be completely washed out at a minimum of every second load.
- .7 Concrete delivered to the work site using agitating trucks, shall be discharged completely within 90 minutes after the mixing water was added to the cement and aggregates. This time may be reduced under conditions contributing to quick stiffening of the concrete or when the temperature of the air is 29°C or above.

- .8 When concrete is transported by means of non-agitating equipment, discharge shall be completed within 30 minutes after introduction of the mixing water to the cement and aggregates.
- .9 Each load of concrete delivered to the job site shall have a delivery ticket issued at the batch plant, showing the following minimum information;
 - .1 The Contract Number;
 - .2 The truck number;
 - .3 The date and time loaded and the time of the first mixing of the water with the cement and aggregates; and
 - .4 The volume of the truck load (batch).
- .10 The Contractor shall issue the delivery tickets.
- .11 Concrete shall be used as long as its consistency and workability meet the job requirements. Additional water may be added to the concrete after the initial mixing water has been added, if the measured slump at the start of discharge is less than that specified, and the time between batching and the start of discharge has not exceeded 60 minutes. The addition of water shall not cause the water / cement ratio to be exceeded. Water shall not be added to the batch at any later time
- .12 When non-agitating trucks are used, the design slump of the concrete shall not be greater than 30mm.

3.10 PLACING

- .1 Main-lane pavements, 8.6m or less in width, shall be constructed in one complete pass using a self-propelled slip form paver.
- .2 The plastic concrete shall be uniformly discharged, full width in front of the spreader in a manner which prevents segregation of the mixed material.
- .3 The slip form paver shall spread, consolidate, screed, and float finish the freshly placed concrete, to provide a dense and homogeneous pavement. Hand finishing shall be kept to a minimum.
- .4 The mixing, placing and spreading operations shall be performed in a continuous, uniform, forward movement. Vibrating and tamping shall cease immediately upon the paver's forward movement being stopped.
- .5 The slip form paver shall construct the pavement true to the specified grades and alignments.
- .6 Paving equipment riding on steel side forms will be permitted to construct non main-lane pavements.
- .7 When side forms are used the concrete adjacent to the side forms and fixed structures shall be placed to the required depth and thoroughly consolidated with a portable vibrator. The vibrator shall not contact the base while it is being operated nor shall it be used to move the concrete horizontally.

- .8 Equipment paving adjacent to a slab previously placed will be permitted to operate on that slab. Damage to the adjacent existing concrete, caused by the paving equipment, shall be repaired at the Contractor's expense.
- .9 Joints in adjacent lanes of pavement shall align with joints in previously placed concrete.
- .10 Two-lift construction or other special construction methods will not be permitted without prior written approval. Where approval is given to use two-lift construction, the first lift shall be roughly struck off with a template or screed at the correct elevation to place the reinforcing steel as shown on the drawings. The concrete above the reinforcing steel shall be placed within 15 minutes after the first lift has been placed. Any dust, dirt, or other foreign matter which collects on the first lift shall be removed before the second lift is placed.
- .11 A transverse construction joint may be required to close a section when the continual placing of concrete is delayed. The construction joint shall be located between the contraction joints

3.11 FINISHING

- .1 After the concrete has been placed, it shall be struck off by a finishing machine or a slip form paver designed to perform the finishing as one of its operations.
- .2 The finishing machine shall be designed and operated to strike off and consolidate the concrete, eliminate ridges and produce an even surface true to the specified grades and alignment. The operation of the machine shall be controlled to keep the coarse aggregate near the finished surface of the pavement. Repeated operation of the machine over any area shall be avoided.
- .3 There shall be no noticeable water on the surface before hand finishing.
- .4 After finishing, the Contractor shall test the smoothness of the pavement surface with a 3-metre metal straightedge. Noticeable deviations shall be corrected at this time.
- .5 As a final finishing operation, the pavement surface shall be textured to a broomed, tined or diamond ground finish in the transverse or longitudinal direction.
- .6 When a broomed surface is specified, it shall be completed before initial set has developed and when the concrete will not be torn or excessively roughened. Brooms shall be clean and free from an accumulation of hardened cement. The stroke of the mechanical broom shall be made, without stopping, for the full width of the concrete, with the adjacent strokes overlapping. Sufficient pressure must be exerted on the broom to produce a uniformly serrated surface. The broom marks shall be approximately 2.5mm deep. Handheld brooms will not be permitted on pavement lanes exceeding 5.0m widths unless a work bridge is provided that spans the full width of the fresh pavement.

- .7 The surface shall be free in all cases from displaced aggregate particles and local projections

3.12 CURING

- .1 Upon the completion of concrete finishing, all exposed surfaces shall be sprayed with the curing liquid to completely cover the surfaces in accordance with the manufacturer's recommendations. The Contractor shall use a curing compound listed on the MIT's Approved Products List (APL). When side forms are used, the pavement's vertical sides shall be sprayed immediately after the forms are removed
- .2 Apply in two coats with approved spray equipment to form complete and unbroken film on surface of concrete. Mechanically agitate compound before and during use.
- .3 Protect formed or sawed joints from evaporation during curing period.
- .4 Respray areas where membrane is damaged during curing period.
- .5 White pigmented curing compound shall be applied to all exposed surfaces of concrete as soon as the finishing operation is completed without damaging the surface to completely cover the surface in accordance with manufacturer recommendation.
- .6 For fixed-form placements, where the framework is removed in less than 96 hours, the sides of the exposed concrete faces shall be covered with a white pigmented curing compound at the manufacturer's specified rate of application.
- .7 Curing compound shall not be applied to joint faces receiving sealant or to concrete surfaces to which concrete or mortar is to be bonded.
- .8 If curing compound is applied in areas where centreline and shoulder line are to be painted for highway pavement marking, the Contractor shall remove it completely from the concrete surface prior to the application of pavement marking paint in these areas.
- .9 The method of removal shall be by abrasive shot blasting and not result in any damage to the concrete surface. It shall also meet all environmental constraints as specified in the Contract document.

3.13 JOINTS

- .1 Layout of all transverse and longitudinal joints shall be the responsibility of the Contractor and will be in accordance with the Drawings.
- .2 All joints shall be sawn. The Contractor shall have a minimum of 2 concrete saws and sufficient auxiliary equipment on the job to insure that joint sawing is completed within the required time limits.
- .3 Transverse and longitudinal joints shall be sawn in conjunction with one another and begin as soon as the concrete surface has hardened sufficiently to resist ravelling as the cut is made.

- .4 Transverse and longitudinal joints shall be sawn to the width and depth shown on the Drawings.
- .5 All the residue within each joint and on the pavement surface shall be removed after the sawing of that joint is completed.
- .6 Sawed joints which are ravelled or do not conform to the specified size and shape shall be repaired before the sealant is installed.
- .7 Expansion joints may be required adjacent to fixed structures and at other locations directed by the Department. They shall be constructed as shown on the Drawings.
- .8 If a fibre joint filler is required, it shall be supported rigidly in place while placing the concrete. Immediately after the finishing of the pavement is completed, the concrete over the filler shall be cleaned out and the edges of the slab on each side of the joint shall be rounded with an edging tool to a radius of 6mm.
- .9 All reinforcing steel shall be placed in accordance with the details shown on the Drawings.

3.14 REMOVING FORMS

- .1 Forms shall remain in place for a minimum of 12 hours after the concrete has been placed, unless permitted otherwise. Forms shall be removed without damaging the pavement.

3.15 GROUTING STEEL

- .1 The Contractor shall supply and install anchoring grout capsules wherever existing concrete pavement or new concrete pavement must be drilled for the installation of load transfer dowels, deformed dowels, or deformed tie bars. The grout anchoring capsules shall be installed according to the manufacturer's recommendations.
- .2 Tie bar and dowel bar holes shall be blown clean with compressed air before grouting.
- .3 Excess grout shall be cleaned from the area surrounding the hole prior to curing.

3.16 PROTECTION

- .1 Do not open concrete pavement to traffic or construction equipment until approved by Department Representative.
- .2 When placing concrete in lanes adjacent to existing concrete, operate placing equipment on rubber wheels or pads to prevent damage to existing surface.

3.17 WEATHER LIMITATIONS

- .1 During hot weather, the temperature of the mix shall be kept as low as possible and shall not exceed 32°C. Aggregates or water, or both shall be cooled to reduce the concrete's temperature.

- .2 Additional measures shall be taken to prevent rapid moisture loss from the concrete surface.
- .3 The Contractor shall suspend paving operations if weather conditions increase the risk of cracking, as agreed by the Departmental Representative.
- .4 The Contractor shall have a protective cover available at all times to protect the surface from rain before the concrete has sufficiently hardened. Paving shall stop immediately when rain starts and the concrete shall be covered with the protective cover.
- .5 Paving will not be allowed when the ambient temperature is below 0°C.
- .6 Paving may start when the ambient temperature is between 0°C and 5°C depending on the weather forecast, type of work, and quantity of concrete to be placed.
- .7 The Contractor shall provide sufficient insulated tarps or other approved protective coverings to maintain a minimum temperature of 10°C on the concrete surfaces for a minimum of 48 hours after it has been placed. If the air temperature drops below 0°C during this 48-hour period, the pavement shall be covered for a further 5 days.
- .8 Sufficient weights shall hold the tarps in place. Additional payment will not be made for any of these protective measures.
- .9 When the concrete is protected by insulation no more than 25 linear metres of concrete pavement shall be exposed for saw cutting operations. In no case shall concrete pavement be exposed more than one hour.

3.18 PRODUCT ACCEPTANCE

- .1 Concrete Strength
 - .1 The 28 day compressive strength will be determined from concrete cylinder specimens cast and tested by the Department. If the cylinder specimens fail to meet 85% of the minimum compressive strength specified, the department will obtain core specimens from the suspect areas of the concrete and their compressive strengths determined in accordance with the latest edition of CSA Standard A23.1 and A23.2
 - .2 If the core results determine that the concrete did not meet the minimum compressive strength requirement, then the areas represented by the cores will not be eligible for full payment.
 - .3 If the average of the compressive strengths of the cylinders are at least 85% of the specified strength requirement and no single cylinder is less than 75% of the specified strength, the concrete will be deemed to have met the strength requirement. If the compressive strengths of the cylinders are less than 85% of the specified compressive strength, the following will apply:

- .1 Less than 85% but greater than 80% - Payment for the concrete will be reduced by \$25 per square metre.
 - .2 Less than 80% but greater than 70% - Payment for the concrete will be reduced by \$50 per square metre.
 - .3 Less than 70% - The concrete shall be removed and replaced at the Contractor's expense
- .2 Surface Smoothness
- .1 For surface smoothness, the surface profile will be measured and provided by the Contractor using a profile measuring device capable of simulating a California Profilograph. The readings will be taken in each wheel path of the mainline pavement. The International Roughness Index (IRI) will be determined by using the average wheel path results per 100m section in each driving lane. The Departmental Representative will determine the final ride quality based on the results of the profile data. Surface evaluation procedures will be as follows:
 - .1 Each lane is divided into 100 meter sections
 - .2 Remaining subsections shorter than 100 meters will be prorated for equivalency in the riding quality.
 - .3 Each section shall have a maximum IRI of 1.026 metres per km per 100 metres.
 - .4 Sections in excess of the maximum IRI shall be corrected by the Contractor
 - .2 On pavement sections where corrections have been made, a second profile measurement will be performed to verify that the corrections have produced a maximum IRI value as shown in the Special Provisions. Corrected areas which fail to meet the smoothness requirements will require further correction. No additional payment will be made to the Contractor for any further corrective action required as this will be considered incidental to the bid item for Concrete Texture Planing.
 - .3 The procedures for appealing the acceptance test results shall be as follows:
 - .1 The Contractor may appeal the acceptance testing for smoothness of any 100-metre section only once.
 - .2 This appeal must be made within 2 calendar days of receiving the test results.
 - .3 The new test results will be binding on both the Contractor and the Departmental Representative.
 - .4 Pay adjustment in lieu of correction for individual bumps or dips per 7.6 metres, will be made according to the following schedule:

Method of Measurement	Bump or Dip Measured in the Vertical Direction		Price Adjustment per Bump or Dip (\$)
	Bump	Dip	
Laser Profiler	> 8 but < 12mm	> 8 but < 12mm	\$600 Deduction or Correct
Laser Profiler	12mm or greater	> 12mm but < 16mm	Correct or Remove and Replace
Concrete Core		16mm or greater variation from design thickness	Remove and Replace

.5 All work involved in the correction or removal and replacement of the concrete shall be done at the Contractor's expense.

.3 Cracked Concrete

.1 Concrete with cracking that extends greater than 1/3 of the slab thickness shall be removed and replaced, or at the Departmental Representative's option accepted with payment reduction of \$100 per square metre. Concrete with cracking that extends less than 1/3 of the slab thickness may be repaired by methods approved by the Departmental Representative. All work to remove and repair cracked concrete will be at the Contractor's expense

.4 Pavement Width

.1 For the concrete pavement width to be accepted, the average pavement width shall not be more than 15mm less than the design pavement width.

.5 Pavement Thickness

.1 For the concrete pavement thickness to be accepted, the minimum measured shall be not more than 3 mm less than the design pavement thickness.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 31 22 13 Rough Grading
- .2 Specification 32 13 13 Concrete Paving

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A775 Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - .2 ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete.
 - .3 ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .4 ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
 - .5 ASTM D1752 Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- .2 CSA Group
 - .1 CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA-A3000 Cementitious Materials Compendium.
 - .3 CSA G30.18 Carbon Steel Bars for Concrete Reinforcement.
 - .4 CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .3 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 830(I), Specifications for Concrete Pavement [March 2015]
 - .2 Manitoba Infrastructure and Transportation Construction Specification 860(I), Specifications for Concrete Curbing [August 2013]
 - .3 Manitoba Infrastructure and Transportation Construction Specification 870, Specifications for Sidewalk [March 1986]

1.1 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: Company or person specializing Portland cement concrete paving
- .2 Certifications:
 - .1 Submit to Departmental Representative manufacturer's test data and certification that following material meets criteria and requirements of this section prior to starting concrete work:
 - .1 Portland Cement.
 - .2 Admixtures.

- .3 Joint Sealants.
- .4 Curing Materials.
- .5 Joint Filler.
- .2 Submit certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA A23.1/A23.2, and that mix design is adjusted to prevent alkali aggregate reactivity problems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Sampling and Testing
 - .1 Sampling and testing will follow those provided in Section 32 13 13 Concrete Paving.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage of materials shall be in accordance with the requirements of CSA-A23.1, Clause 9, Storage of Materials, except as otherwise specified herein.

Part 2 Products

2.1 MATERIALS

- .1 Concrete walk mixes and materials: in accordance with Section 32 13 13 Concrete Paving
- .2 Concrete curb and gutter mixes and materials in accordance with MIT Specification 860(I)

Part 3 Execution

3.1 SIDEWALKS

- .1 Grade Preparation
 - .1 Do grade preparation work in accordance with Section 31 22 13 Rough Grading.
 - .2 Excavation
 - .1 The limit of excavation shall be determined by the Departmental Representative. The base of the excavation shall be uniformly shaped and firmly compacted. Approved replacement material shall be placed in uniform layers and compacted to 95% of the maximum dry density.
 - .2 Do grade preparation work in accordance with Section 31 22 13 Rough Grading.
- .3 Sand Bed
 - .1 A sand bed shall be placed on the compacted subgrade and rolled or tamped to a sound bearing condition. The sand bed shall be a minimum of 50 mm in thickness and shall consist of clean granular material.

- .4 Protection from Damage
 - .1 Where required, temporary crossings shall be provided by the Contractor during sidewalk construction. The Contractor shall provide a watchman for a continuous period of twelve hours after pouring concrete. The duties of the watchman shall be to protect the concrete from damage.
- .5 Placing Concrete
 - .1 The sand bed shall be moist at the time of placing the concrete. If it is dry, it shall be sprinkled with water in such a manner as to avoid forming pools.
 - .2 Concrete shall be deposited rapidly on the prepared base to the required depth and for the entire width of sidewalk in a continuous operation without bulkheads. Concrete shall be properly worked so as to ensure consolidation and filling of forms.
 - .3 When the placing of concrete is suspended for more than 30 minutes, a contraction joint shall be formed to close the section
- .6 Finishing
 - .1 Newly poured concrete shall be struck off so that it will form a true and even surface.
 - .2 After excess moisture has disappeared, the slab surface shall be given a broom finish before the initial set has developed. Clean brooms shall be used and the strokes shall be made for the full width of the lane with adjacent strokes overlapping.
 - .3 The outside edge and joints of the sidewalk shall be finished with an approved edging tool.
- .7 Expansion Joints
 - .1 Expansion joints shall be provided every 7.5 m by placing a 6 mm by 100 mm strip of filler fully across the walk. An expansion joint shall be provided where sidewalk meets the curb, and where it butts against buildings, poles, hydrants or any other object which could restrict expansion.
- .8 Contraction Joints
 - .1 Contraction joints shall be sawn at least 25 mm deep, at 1.5 m intervals.

3.2 CURB AND GUTTERS

- .1 Curb and Gutter on Roadways
 - .1 When curbing is to be constructed on a granular base course, other than in a trench, the Contractor shall perform his operation so that:
 - .1 the final lift of base course is not constructed until the Curb and Gutter has been placed and cured.
 - .2 granular base course lifts are not less than 50 mm nor more than 100 mm in thickness
 - .3 granular base course under the proposed curb is constructed slightly above the design elevation and fine graded. Should the granular base course lose density, due to a time delay between fine grading and the

extrusion operation, the Contractor shall re-compact the granular base course to the specified density

- .2 The design thickness of granular base course may require the Contractor to construct a pad of base course under the proposed curb to meet the above requirements
- .2 Curb and Gutter in Trenches
 - .1 Where a trench excavation is required to accommodate a granular base course and concrete curb, material shall be excavated to the specified width and depth. The subgrade shall be compacted to 95% AASHTO Standard Dry Density. In the event of adverse moisture conditions in the subsoil, the Departmental Representative may approve the use of other specialized methods and equipment, including lime supplied by the Department.
 - .2 The base course shall be constructed to the elevation staked by the Departmental Representative, compacted to 98% AASHTO Standard Dry Density and waterproofed with undiluted emulsion.
 - .3 The Contractor shall backfill behind the curb to match the level of the existing ground. Excess material shall be disposed of at a location provided by the Contractor and approved by the Departmental Representative.
- .3 Dowels
 - .1 Concrete Curb and Gutter to be constructed on top of or adjacent to existing concrete pavement shall be tied into the pavement using deformed dowels.
 - .2 Holes drilled for dowels shall have a maximum diameter of 19 mm. Dowels shall be secured in the drill holes using an epoxy cement
- .4 Hauling Concrete
 - .1 Mixer and agitator trucks used to transport concrete shall be capable of delivering the concrete thoroughly mixed. The concrete shall meet the requirements for slump, air content and uniformity when it is discharged at the site. Water shall not be added during transportation. Unless otherwise permitted, concrete shall be delivered to the site and discharged within one hour of the time the cement was added to the mix.
 - .2 A batch ticket showing the volume of the load and time of batching shall be provided with each load of concrete supplied by a Ready Mix Supplier.
 - .3 When required by the Departmental Representative to verify yield, hauling equipment shall be weighed on a platform scale before and after the discharge of concrete
- .5 Placing Concrete
 - .1 An approved slip form Curb and Gutter machine shall be used to construct Curb and Gutter except where conditions make the use of the machine impractical.
 - .2 Placing concrete on an unstable, saturated or frozen base will not be permitted.
 - .3 If required, the base shall be dampened with water prior to placing concrete.
 - .4 The supply of concrete to the machine shall be sufficient for uninterrupted placement to the full width and depth of the mould on the Curb and Gutter machine.

- .5 The slip form Curb and Gutter machine shall be operated using a stringline to maintain profile and alignment. Concrete Curb and Gutter will be rejected if the profile or alignment deviates in excess of 6 mm in 3 m from the design alignment and gradeline.
 - .6 Test cylinders will be obtained and slump and air content will be checked by the Departmental Representative at the time of placement. The Contractor shall supply concrete as required for field testing and for test cylinders.
 - .7 When placing of concrete is suspended for more than 45 minutes a construction joint shall be formed and its location shall be at other than a contraction joint.
 - .8 Curb openings such as for driveways and paraplegic ramps shall be constructed by the Contractor.
- .6 Formwork
- .1 Formwork, when required, shall be set to the grade and alignment staked by the Departmental Representative and shall be secured so that no springing or deformation occurs during the placement and consolidation of the concrete.
 - .2 Forms shall be straight and free from warp, and of sufficient strength to resist springing during the depositing and consolidation of the concrete. The top of any form or the contact face of a straight form shall not vary from a true plane by more than 6 mm in 3 metres. Forms for use on curves shall be capable of installation to within 12 mm of the true curve and if the radius is less than 50 metres, shall be either flexible material or shaped to fit the curve. The forms shall be designed so that they may be securely fastened together in the correct position. The top of the form shall be set to the elevation of the top of the Curb and Gutter.
 - .3 Formwork shall be properly cleaned and oiled prior to the placement of concrete. Formwork, in general, shall remain in place for at least twelve hours after concrete placement. Formwork on the curb face shall be removed, as required, to permit texturing.
- .7 Consolidation, Finishing and Curing
- .1 Freshly placed concrete shall be consolidated by the use of immersion type vibrators. Two or more vibrators shall be located in the hopper or mould of the slip form curbing machine.
 - .2 The concrete shall not be finished by hand troweling unless absolutely necessary to produce a smooth level surface. If bleed water is present, troweling shall be delayed until the bleedwater has evaporated or has been removed.
 - .3 After finishing, exposed surfaces shall be textured by brooming in a direction perpendicular to the curb alignment using a stiff bristle brush.
 - .4 Exposed surfaces which have been textured shall be sprayed with a membrane curing liquid, except when the ambient air temperature is below 5°C.
- .8 Joints
- .1 Construction joints shall be formed at the end of each day's pour and when pouring has been delayed in excess of 45 minutes. Construction joints shall be fixed joints tied together with dowels. Dowels shall be placed at the termination of the pour while the concrete is still plastic or by drilling and grouting with epoxy cement prior to the commencement of the adjacent pour. Both sides of the construction joint shall be edged to produce a smooth uniform joint.

- .2 Contraction joints shall be constructed at 3 m intervals or to match existing contraction joints if the Curb and Gutter is tied to existing concrete pavement. Contraction joints shall be sawn, or troweled and edged, to a width of 6 mm and to a uniform depth determined by the Departmental Representative based on one-quarter of the depth of the concrete. Sawing shall be completed before contraction cracking has occurred. Where Curb and Gutter is to be covered because of cold weather, the contraction joints shall be trowelled. The gutter portion of contraction joints shall be filled with a hot pour or mastic joint filler.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for pavement markings and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS.
- .2 Samples:
 - .1 Submit to Departmental Representative the following material sample quantities at least 4 weeks prior to commencing work.
 - .1 Two 1 L samples of each type of paint.
 - .2 Mark samples with name of project and its location, paint manufacturer's name and address, name of paint, MPI specification number and formulation number and batch number.

1.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.3 SITE CONDITIONS

- .1 Sustainable Design Provisions:
 - .1 Seasonal restriction for high VOC content traffic marking coatings.
 - .1 Traffic marking coating application between May 1st and October 15th is subject to seasonal use restriction and must not have a VOC concentration in excess of 150 g/L.

Part 2 Products

2.1 MATERIALS

- .1 Paint and Markings:
 - .1 To MPI #32, Alkyd zone/traffic marking.
 - .2 Traffic Marking Coatings: maximum VOC limit 450 g/L to SOR/2009-264 Schedule 1.

- .3 Paints: in accordance with MPI recommendation for surface conditions.
 - .4 Colour: to MPI listed, white and yellow.
 - .5 Upon request, Departmental Representative will supply qualified product list of paints applicable to work. Qualified paints may be used but Departmental Representative reserves right to perform further tests.
- .2 Thinner: to MPI listed manufacturer.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates and surfaces to receive pavement markings previously installed under other Sections or Contracts are acceptable for product installation in accordance with MPI instructions prior to pavement markings installation.
 - .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Pavement surface: dry, free from water, frost, ice, dust, oil, grease and other deleterious materials.
- .3 Proceed with Work only after unacceptable conditions have been rectified.

3.2 EQUIPMENT REQUIREMENTS

- .1 Paint applicator: approved pressure type with positive shut-off distributor capable of applying paint in single, double and dashed lines and capable of applying marking components uniformly, at rates specified, and to dimensions as indicated.

3.3 APPLICATION

- .1 Pavement markings: laid out by Contractor.
- .2 Unless otherwise approved by Departmental Representative, apply paint only when air temperature is above 10 degrees C, wind speed is less than 20 km/h and no rain is forecast within next 4 hours.
- .3 Apply traffic paint evenly at rate of 3 m²/L.
- .4 Do not thin paint unless approved by Departmental Representative.
- .5 Symbols and letters to dimensions indicated.
- .6 Paint lines of uniform colour and density with sharp edges.
- .7 Thoroughly clean distributor tank before refilling with paint of different colour.

3.4 TOLERANCE

- .1 Paint markings: within plus or minus 12 mm of dimensions indicated.
- .2 Remove incorrect markings.

3.5 CLEANING

- .1 Progress Cleaning: Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment

3.6 PROTECTION

- .1 Protect pavement markings until dry.
- .2 Repair damage to adjacent materials caused by pavement marking application.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-138.1, Fabric for Chain Link Fence.
 - .2 CAN/CGSB-138.2, Steel Framework for Chain Link Fence.
 - .3 CAN/CGSB-138.4, Gates for Chain Link Fence.
- .2 City of Winnipeg
 - .1 City of Winnipeg Standard Construction Specification 3550-R3, Chain Link and Drift Control Fence [January 2014]

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for concrete mixes, fences, posts and gates and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect fence and gate materials from damage.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Terminal Posts
 - .1 Terminal posts, comprising of end, gate, corner and straining posts shall be standard seamless, continuous weld, schedule 40 hot dip galvanized steel pipe weighing 11.28 kg per lineal metre. Posts shall be supplied with weatherproof caps. Tubing, conduit or open seam material will not be accepted.
 - .2 End, gate, corner and straining posts shall be of the lengths and dimensions shown in following table:

2.2

Fence Height mm	Pipe Outside Diameter, mm	Pipe Length mm	Diameter & Depth of Concrete Pile, mm
1220	88.9	2440	300x1800
1830	88.9	3200	300x1800
2440	88.9	3810	300x1800
3050	88.9	4420	300x1800
3660	114.3	5030	400x1800
4880	114.3	6550	400x1800

TABLE 1- Terminal Posts

.1 Line Posts

- .1 Line posts shall be standard seamless, continuous weld, schedule 40 hot dip galvanized steel pipe weighing 5.43 kg per lineal metre. Line posts for fence fabric that is to be 3660 mm and higher shall weigh 8.63 kg per lineal metre. Tubing, conduit or open seam pipe will not be accepted.
- .2 Line posts shall be supplied with weatherproof eye top caps to accommodate continuous horizontal top rail and shall be of the lengths and dimensions shown in the following table:

Fence Height mm	Pipe Outside Diameter, mm	Pipe Length mm	Diameter & Depth of Concrete Pile, mm
1220	60.3	2440	250x1800
1830	60.3	3200	250x1800
2440	60.3	3810	250x1800
3050	60.3	4420	250x1800
3660	73.0	5030	250x1800
4880	73.0	6550	250x1800

TABLE 2 – Line Posts

.2 Top and Bottom Rails

- .1 Top rails, or bottom rails where specified, shall be standard, continuous weld, schedule 40 hot dip galvanized steel pipe weighing 3.38 kg per lineal metre. Top rails shall be 6700 mm in length and have an outside diameter of not less than 43 mm.

.3 Top and Bottom Rail Sleeve Couplings

- .1 Top and bottom rail sleeve couplings shall be schedule 40, hot dip galvanized steel pipe, 171 mm long and 45 mm inside diameter to accommodate a 43 mm outside diameter top rail and manufactured specifically as a top/bottom rail sleeve coupling for chain link fence.

.4 Fabric

- .1 Fabric shall be No. 9 gauge steel wire woven into a uniform 50 mm (2") diamond pattern mesh or as specified. Size of mesh shall be determined by measuring the minimum clear distance between the wires forming the parallel sides of the mesh. Permissible variation in size of mesh shall be 3 mm (1/8"). Diameter of wire shall be no less than 3.68 mm (0.145"). The top and bottom selvage shall be knuckled.

- .2 Fabric shall be zinc coated before weaving by the hot dip process to an average mass per unit area of not less than 490 g/m².
- .3 Mesh fabric shall not be excessively rough, or have blisters, sal ammoniac spots, bruises or flaking.
- .4 Chain link fabric shall have a minimum tensile strength of 415 MPa.
- .5 Bottom Tension Wire
 - .1 Bottom tension wire shall be No. 6 gauge single strand galvanized steel wire
- .6 Turnbuckles
 - .1 Where turnbuckles are specified, they shall be drop forged steel and be hot dip galvanized. The average overall length shall be approximately 300 mm, with ends in the closed position. Bolt diameter shall be 10 mm and shall be capable of taking up a minimum of 150 mm slack.
- .7 Braces
 - .1 Braces, shall be schedule 40 hot dip galvanized steel pipe, not less than 43 mm outside diameter and weigh 3.38 kg per lineal metre.
- .8 Fittings and Accessories
 - .1 Tension bars shall be 5 x 19 mm galvanized flat steel and not less than 50 mm shorter than the height of the fabric with which they are to be used.
 - .2 Tension bands shall be 3 x 19 mm galvanized flat steel c/w 8 x 32 mm galvanized carriage bolts and nuts.
 - .3 Brace bands shall be 3 x 19 mm galvanized flat steel c/w 8 x 32 mm galvanized carriage bolts and nuts to fasten top rail receptacles to terminal posts.
 - .4 Cut ends of tension bars shall be ground smooth to remove all sharp edges and burrs.
 - .5 Fabric clips shall be No. 9 gauge aluminum alloy wire.
 - .6 Weatherproof post tops/caps, receptacles, and fittings shall be of adequate strength and may be of aluminum alloy, malleable steel or pressed steel. All ferrous metals shall be hot dip galvanized
- .9 Concrete
 - .1 Where concrete piles are specified for post installation, the concrete shall conform to CW 2160 and be sulphate resistant type 50, minimum compressive strength of 25 MPa at 28 days, air content of 4% - 7%, maximum slump of 80 mm and a maximum size of course aggregate of 40 mm.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for fence and gate installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Departmental Representative].

3.2 POST INSTALLATION

- .1 Terminal and line posts, except where otherwise specified, shall be installed to a depth equal to the difference between the proposed fence height and the specified pipe length shown in Clauses 5.2 and 5.3 herein. Use hydraulic equipment to push or pound posts into the existing ground.
- .2 Where concrete piles are specified for post installation, they shall be of the lengths and dimensions shown in Clauses 5.2 and 5.3 herein. Posts shall be set in the centre of the concrete pile. Tops of concrete piles shall be crowned or domed to shed water and be installed 100mm below the finished grade. Concrete piles shall be constructed in accordance with CW 2160.
- .3 Posts shall be plumbed and set to give correct alignment. Bending of posts to give correct alignment is not acceptable.
- .4 Weatherproof post tops/caps shall be securely attached to eliminate removal by hand. Eye top caps shall allow for the insertion of a top rail in a horizontal position.
- .5 Maximum spacing between centerline of posts shall not exceed 3050 mm.
- .6 Straining posts shall be installed at all sharp changes in grade and where directed by the Departmental Representative.

3.3 FABRIC INSTALLATION

- .1 Fabric shall be stretched taut to the correct tension as specified by the manufacturer and to the Departmental Representative's satisfaction. Where posts have been installed in concrete piles, fence fabric shall not be installed until piles have cured for a period of not less than five (5) days. Fabric shall be installed on the outside of the fence unless requirement for installation on the inside of the fence is specified.
- .2 Clearance between bottom of fabric mesh and ground surface shall be no less than 40 mm or more than 50 mm unless otherwise indicated on the drawing or approved by the Departmental Representative.
- .3 Fabric clips shall be used to fasten the fabric to the top rail at 450 mm spacing and to line posts at 380 mm maximum spacing. Wires ties on the top rail and bottom rail or tension wire shall have a minimum of two twists around mesh.
- .4 Tension bars, bands and bolts shall be used to fasten the fabric to terminal posts. Maximum spacing for tension bands and bolts shall be 380 mm. Top of tension bars shall not protrude above the bottom of the top rail.
- .5 The bottom tension wire shall be stretched taut along the bottom of the fabric and securely attached to all terminal and line posts and attached to the bottom edge of the fabric at 450 mm maximum spacing using hog rings.

3.4 TURNBUCKLES

- .1 Where turnbuckles are specified for installation, they shall be used to stretch the bottom tension wire taut and be able to take up a minimum of 150 mm slack.

3.5 BRACES

- .1 Braces, where specified only, shall be placed either horizontally or diagonally from the terminal post to the first adjacent line post. Braces shall be secured to posts in accordance with construction drawing details and/or to the satisfaction of the Departmental Representative.
- .2 Corner and straining posts shall have braces on both sides.

3.6 MID RAILS

- .1 Mid rails for 4880 mm high fences shall be installed at a height of 2440 mm above the finished grade in accordance with construction drawing details and/or to the satisfaction of the Departmental Representative.

3.7 GATES

- .1 Gate frames shall be made from schedule 40 hot dip galvanized steel pipe; not less than 43 mm outside diameter, electrically welded at all joints with ample bracing to provide a rigid frame free from sag or twist.
- .2 Gate height shall match the height of the fence unless otherwise specified.
- .3 No. 9 gauge chain link fabric as specified in Clause 5.6 herein shall be attached to gate panels in accordance with Clause 9.3 herein. Top and bottom fabric selvage shall be knuckled.
- .4 Gates shall be supplied and installed complete with hot dip galvanized malleable iron hinges, latches, chain holdbacks, and a gate latch suitable for padlock, which is accessible from either side. Gates 3000 mm or more in width shall have three hinges per section.
- .5 Hinges shall permit the gate to swing back 180° degrees in line with the fence and shall be installed so as not to permit easy removal of the gate.
- .6 If requested by the Departmental Representative, the Contractor shall supply shop drawings of all gates to be supplied prior to manufacture for the Departmental Representative's approval.

3.8 ZINC COATING REPAIRS

- .1 All abraded and damaged galvanized surfaces shall be cleaned and painted. Damaged surface areas shall be thoroughly grinded or wire brushed and all loose and cracked zinc coating removed, after which the cleaned area shall be painted with two coats of a zinc pigmented paint approved by the Departmental Representative for these purpose.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 32 92 19.13 Mechanical Seeding

1.2 REFERENCES

- .1 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 550, Specifications for Landscaping [July 2011]

Part 2 Products

2.1 TOPSOIL

- .1 Topsoil shall consist of an imported clay textured or loam textured dark peat, a friable material containing no more than 25% nor less than 5% by volume organic matter (peat, rotted manure or composted materials). It shall be free of roots and any subsoil clay lumps, stones and roots over 15mm diameter and free of any other extraneous material.

2.2 SOD

- .1 Sod shall be supplied by the Contractor and shall consist of the following alternatives:
 - .1 Nursery sod grown from Canada No. 1 Kentucky Blue Grass or a mixture of Kentucky Blue and Creeping Red Fescue.
 - .2 Cultured sod produced from native grass sod improved by top seeding with Canada No. 1 grade Kentucky Blue Grass after at least two years of maintenance in the field.
- .2 Sod shall be healthy field grown sod containing not more than 12 mm thick thatch. The age of the sod shall be not less than 8 months or more than 16 months. Sod shall be machine cut at a uniform soil thickness of 15 mm \pm 6 mm, not including top growth and thatch.
- .3 The sod shall be free from disease, weeds, insects, and non-desirable types of grasses and clovers. The sod field shall contain a good stand of grass without couch grass present in the sod. The Departmental Representative will not accept sod sections with couch grass.
- .4 The sod shall have a soil base of 25 mm and shall be mowed to a height of 40 mm prior to delivery. Sod shall be protected with tarps or other protective covers during delivery and shall not be allowed to dry out during delivery or prior to placement

Part 3 Execution

3.1 STORAGE

- .1 The Contractor shall exercise care to retain the native soil on the roots of the sod during the transplanting operations. Dumping of sod from vehicles will not be permitted. Sod

shall be planted within 24 hours from the time of harvesting, unless it is tightly rolled or stored roots to-roots in a satisfactory manner. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing. The maximum period of storage shall be five days. Sod that is dry or fails to meet the specification requirements will be rejected

3.2 NOTIFICATION

- .1 The Contractor shall notify the Departmental Representative at least 48 hours in advance of the time he intends to begin sodding and shall not proceed with such work until permission has been granted. No frozen sod shall be placed nor shall sodding be done on frozen earth. Sodding operations will not be permitted when, in the opinion of the Departmental Representative, frost, excessive moisture or other conditions indicate that satisfactory results are not likely to be obtained.

3.3 TOPSOIL

- .1 Topsoil shall be placed on the graded subsoil, so that after grading and compacting, the topsoil is 25 mm lower than the finished curb or sidewalk. The topsoil layer shall be a minimum of 75 mm in thickness after compaction. Areas shall be harrowed or raked prior to placing the sod. The soil on which the sod is to be laid shall be reasonably moist and shall be watered by the Contractor if so directed by the Departmental Representative.

3.4 LAYING SOD

- .1 Weeds and debris shall be removed before cultivation and shall be disposed of. Areas to be planted to sod shall be graded to drain and shall be smooth and uniform prior to placing sod.
- .2 The sod shall be laid smoothly, edge to edge. Sod shall be placed firmly against adjacent sod and against sidewalks, concrete headers, header boards, and other paved borders and surfaced areas. These areas shall be 25mm \pm 5 mm below the top grade of the facilities, after fine grading, rolling, and settlement of the soil. All openings shall be plugged with sod. Vertical joints between sod shall be staggered. Sod shall be laid starting at the base of slopes and progressing upward in continuous parallel rows.
- .3 Immediately after laying, sod shall be pressed firmly into contact with the sod bed by tamping, rolling or by other approved methods so as to eliminate air pockets, provide true and even surfaces, insure knitting and to protect all exposed sod edges, but without displacement of the sod or deformation of the sod surface.
- .4 If irregular or uneven areas appear before or during the plant establishment period, these areas shall be restored to a smooth and even appearance.

3.1 WATERING

- .1 The newly sodded areas shall be watered evenly at a rate of 11 L/m², unless otherwise directed.
- .2 When the sod is watered, sufficient water shall be applied to wet the sod at least 50 mm into the sod bed. Watering shall be done in a manner that will not cause erosion or other damage to the finished surfaces. Any surfaces that become gullied or otherwise damaged shall be repaired to re-establish the grade and conditions of the soil prior to sodding and shall then be re-sodded as specified under this work. Sod shall not be allowed to dry out.

3.2 MAINTENANCE AND ACCEPTANCE

- .1 The Contractor shall be responsible for maintaining all sodded areas until acceptance by the Departmental Representative. When the Departmental Representative determines that an area of sod has failed, for any reason, to produce a satisfactory turf before the expiry of the one year time period as outlined in the General Conditions, the Contractor shall re-sod such areas in the same manner as specified in the contract until a satisfactory turf has been established. Any work to be corrected shall be at the Contractor's expense. Final acceptance of the work will not be made by the Department until a satisfactory turf has been produced. The Departmental Representative will reserve the right to refuse acceptance of any landscaped areas if shown to be poorly knit, have a deformed surface, uneven in distribution, discoloured or otherwise unhealthy.
- .2 Any further preparation and re-sodding required shall be done wholly at the contractor's expense at the earliest opportunity, weather and season permitting.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 32 91 19.13 Topsoil Placement and Grading

1.2 REFERENCES

- .1 Manitoba Infrastructure and Transportation
 - .1 Manitoba Infrastructure and Transportation Construction Specification 540, Specifications for Seeding [July 2011]

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule sod laying to coincide with preparation of soil surface.
 - .2 Schedule sod installation when frost is not present in ground.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.
 - .2 Fertilizer must be dry.
- .2 Storage and Handling Requirements:
 - .1 Store fertilizer in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.5 WARRANTY

- .1 For seeding, 12 months warranty period is extended to 24 months.

Part 2 Products

2.1 GRASS SEED

- .1 Canada "Certified" seed, "Canada No. 1 Lawn Grass Mixture" in accordance with Government of Canada "Seeds Act" and "Seeds Regulations".
- .2 The seed shall be free of disease and mixed by percentage (%) to weight.
- .3 Class 1 Cultivars shall consist of equal proportions of any three of the following.
- .4 The entire proportion of the blend specified shall consist of any one of the following:

Admire	Charger II	Jet	Panther	Quest II
Affinity	Charismatic	Inspire	Paradigm	Racer
Advent	Churchill	IQ	Paragon	Racer II

Affirmed	Citation Fore	Kokomo	Passport	Radiant
All Star 2	Courage	Koos R-71	Pearl II	Renaissance
Allsport	Cruiser	Lp 1	Pennant	Salinas
Amazing	Dazzle	Line Drive	Pennant II	Secretariat
Applaud	Divine	Linn	Pentium	Seville II
Arrival	Edge	LS 2100	Phantom	Skyhawk
Ascend	Elka	Mach 1	Pick EX2	Splendid
Barlennium	Elfkin	Majesty	Pick PRNGS	Stellar
Blazer IV	Exacta	Manhattan 2	Pinnacle II	Summerset
Brightstar	Extreme	Manhattan 3	Pizzazz	Subkissed
Brightstar II	Fiesta 3	Manhattan 4	Pleasure XL	Superstar
Buccaneer	Gallery	Mepy	PR 1-94	Terradyne
BY-100	Gator	Monterey II	Premier	Wilmington
Cabo	Gator 3	MP 103	Premier II	Yatsugreen
Calypson II	Grand Slam	Nighthawk	Promise	
Catalina	Hawkeye	Nexus	Proport	
Catalina II	Headstart	Pacesetter	Protyme	
Cathedral II	Icon	Palmer II	Prowler	

2.2 WATER

- .1 Free of impurities that would inhibit germination and growth.

2.3 HERBICIDES

- .1 Herbicides shall be standard commercial products registered for sale and use in Canada under the Pest Control Products Act.

2.4 INSECTICIDES

- .1 Insecticides shall be standard commercial products registered for sale and use in Canada under the Pest Control Products Act.

Part 3 Execution

3.1 PREPARATION

- .1 The Contractor shall not commence seeding operations until the finished topsoil surface is inspected and approved by the Departmental Representative.

3.2 SEED PLACEMENT

- .1 Grass seed shall be sown at a rate of 1.0 kilogram per 100 square metres.
- .2 Seeding shall commence immediately upon completion of trimming operations. Within the limits, the Contractor shall seed the areas along the side slopes, ditch bottoms, and backslopes throughout the entire length of the project. Areas to be seeded shall be harrowed as part of final trimming operations prior to seeding, and again upon completion. Harrowing after the seeding operation may be undertaken as a separate

operation or in conjunction with the seeding operation. Rutting or damage caused by the Contractor's operation shall be repaired at the Contractor's expense.

- .3 Foreign debris collected during harrowing operations shall be removed and disposed of by the Contractor.
- .4 Water shall be applied in sufficient quantities and frequencies to obtain seed germination and growth. Watering shall be controlled to prevent seed washout.
- .5 Seeding operations shall not be carried out under adverse conditions of high winds, frozen ground, or ground covered with snow, ice, or standing water.

3.3 FINAL ACCEPTANCE

- .1 Seeded areas will be accepted by Departmental Representative provided that:
 - .1 Areas are uniformly established free of rutted, eroded, bare or dead spots and extent of weeds apparent in grass is acceptable.
 - .2 Areas have been fertilized.
- .2 Areas seeded in fall will be accepted in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

3.4 MAINTENANCE DURING WARRANTY PERIOD

- .1 Perform following operations from time of acceptance until end of warranty period.
 - .1 Water seeded area to maintain optimum soil moisture level for continued growth of grass. Control watering to prevent washouts.
 - .2 Repair and reseed dead or bare spots to satisfaction of Departmental Representative
 - .3 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.

END OF SECTION