# CORPORATION OF THE TOWNSHIP OF ESQUIMALT

# SUBDIVISION AND DEVELOPMENT CONTROL BYLAW

## SCHEDULE 'C'

## DESIGN AND CONSTRUCTION SPECIFICATIONS

## ROADWAYS

## APPENDIX


| | | PAGES |
|---|---|---|
| Appendix 1 | Asphaltic Materials | 6 |
| Appendix 2 | Base and Sub-base Preparation | 3 |
| Appendix 3 | Surface Preparation for Asphalt Paving | 3 |
| Appendix 4 | Asphaltic Concrete Paving | 11 |
| Appendix 5 | Surface Treatments | 6 |
| Appendix 6 | Inspection and Testing | 2 |
| Appendix 7 | Methods of Test | 2 |
| Appendix 8 | Concrete | 3 |
| Appendix 9 | Cement Concrete Pavement | 17 |

## 1.0 Preliminary and General

### 1.01 Scope

a) This Specification describes the requirements for the different types and grades of asphaltic materials and additives to be supplied for highway use.

b) The materials so described are generally classified as follows:

Asphalt Cements; Liquid Asphalts; Emulsified Asphalts and Cationic Emulsified Asphalts.

### 1.02 Quality Control Requirements

a) Quality Control System

1. The supplier shall develop and maintain an effective quality control system in accordance with the provisions of this Specification. The system shall ensure that adequate inspection coverage coverage is maintained throughout the entire process of manufacture and shipping.

2. Supplies not conforming to contractual requirements shall not be offered for use until the deviations have been authorized by the Consulting Engineer.

b) Quality Control Procedure - The supplier may be required to furnish the Consulting Engineer with an outline of his quality control procedures detailing his method of implementing the requirements of this Specification. This outline shall include the following operations: receiving, blending and processing, sampling and testing, storage and handling, shipping, recording and reporting.

1.03 Sampling and testing - The supplier shall possess adequate sampling equipment, employ satisfactory sampling procedures and maintain a suitable sampling program. Representative samples from filled shipping containers shall be examined by the Consulting Engineer to ensure quality. (Refer to Appendix 7 for Methods of Test.)

### 1.04 Delivery of Asphaltic Materials

Temperature of Shipment - Where specified, bituminous materials shall be shipped hot. The temperature for shipment shall be subject to arrangement between the Contractor and supplier but generally the supplier should endeavour to ship bituminous materials at such temperatures that on arrival its temperature shall be such that the Kinematic Viscosity of material shall be as below:

| Class of Materials | Kinematic Viscosity, Centistokes |
|---|---|
| Liquid bitumen materials for surface spraying | 100 - 200 |
| Liquid bituminous material and asphalt cements for plant mixing purposes | 150 - 400 |

Subject to the above requirements, asphalts shall normally be shipped within the temperature ranges given in the following table. In no case shall asphalt be shipped at a temperature greater than the designated maximum.

| Loading Temperatures | Min. °C | Max. °C |
|---|---|---|
| Paving Asphalt Cements | 145 | 205 |
| RC-70 | 50 | 80 |
| RC-250 | 65 | 90 |
| RC-800 | 80 | 105 |
| RC-3000 | 105 | 135 |
| MC-30 | 35 | 80 |
| MC-70 | 50 | 80 |
| MC-250 | 65 | 90 |
| MC-800 | 80 | 105 |
| MC-3000 | 105 | 135 |
| SC-70 | 50 | 80 |
| SC-250 | 65 | 120 |
| SC-800 | 80 | 135 |
| SC-3000 | 105 | 160 |
| Special Prime | 25 | 65 |
| RS-1 | 15 | 55 |
| SS-1 | 15 | 55 |
| SS-1h | 15 | 55 |
| CRS-1 | 15 | 55 |
| RS-2 | 45 | 70 |
| MS-2 | 45 | 70 |
| MS-2h | 45 | 70 |
| CRS-2 | 45 | 70 |

2.0 Asphalt Cements

2.01 Asphalt Cements shall:

a) be products prepared by the refining of crude petroleum.

b) be homogeneous, free from water and shall not foam when heated to 175°C.

c) be supplied in such grades as may be ordered.

d) comply with the following detailed requirements and the requirements of A.S.T.M. Specification D-946.

| Grade | 60-70 | | 85-100 | | 120-150 | |
|---|---|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. |
| Penetration at 25°C 100 g, 5 seconds | 60 | 70 | 85 | 100 | 120 | 150 |
| Flash point, °C (Cleveland open cup) | 232.2 | | 232.2 | | 218.3 | |
| Ductility at 25°C 50 mm per min., mm | 1000 | | 1000 | | 1000 | |
| Retained penetration after thin-film oven test, percent | 52+ | | 47+ | | 42+ | |
| Solubility in trichloroethylene percent | 99.0 | | 99.0 | | 99.0 | |
| Ductility at 25°C 50 mm/min., mm after thin-film oven test | 500 | | 750 | | 1000 | |

## 3.0 Liquid Asphalts

### 3.01 General Description

a) Liquid asphalts shall consist essentially of petroleum derivatives and shall be substantially free from water and other impurities.

b) Liquid asphalts shall be of the type and grade described in the following tables, and shall comply with the requirements of A.S.T.M. Specification D-2026 (slow-curing type), A.S.T.M. Specification D-2027 (medium-curing type) and A.S.T.M. Specification D-2028 (rapid-curing type).

1. Slow-Curing Type Liquid Asphalt:

| DESIGNATION | SC-70 | | SC-250 | | SC-800 | | SC-3000 | |
|---|---|---|---|---|---|---|---|---|
| REQUIREMENTS | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. |
| Kinematic viscosity at 60°C, cSt. | 70 | 140 | 250 | 500 | 800 | 1600 | 3000 | 6000 |
| Flash point (Cleveland open cup)°C | 65.5 | | 79.4 | | 93.3 | | 107.2 | |
| Distillation Test: Total Distillate to 360°C percent by volume | 10 | 30 | 4 | 20 | 2 | 12 | | 5 |
| Kinematic viscosity on distillation residue at 60°C, stokes | 4 | 70 | 8 | 100 | 20 | 160 | 40 | 350 |
| Asphalt Residue: Residue to 100 penetration, percent | 50 | | 60 | | 70 | | 80 | |
| *Ductility of 100 penetration residue at 25°C, mm | 1000 | | 1000 | | 1000 | | 1000 | |
| Solubility in trichloroethylene, | 99.9 | | 99.0 | | 99.0 | | 99.0 | |
| Water, percent | | 0.5 | | 0.5 | | 0.5 | | 0.5 |

*Note: If the ductility at 25°C is less than 1000, the material will be acceptable if its ductility at 15.5°C is more than 1000 mm.

2. Medium-Curing Type Liquid Asphalt:

| DESIGNATION | MC-30 | | MC-70 | | MC-250 | | MC-800 | | MC-3000 | |
|---|---|---|---|---|---|---|---|---|---|---|
| REQUIREMENTS | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. |
| Kinematic viscosity at 60°C, cSt. | 30 | 60 | 70 | 140 | 250 | 500 | 800 | 1600 | 3000 | 6000 |
| Flash point (Tag open cup), °C | 37.8 | | 37.8 | | 65.5 | | 65.5 | | 65.5 | |
| Distillate Test: Distillate, percent by volume of total distillate to 360°C: | | | | | | | | | | |
| to 225°C | | 25 | | 20 | | 10 | | | | |
| to 260°C | 40 | 70 | 20 | 60 | 15 | 55 | | 35 | | 15 |
| to 316°C | 75 | 93 | 65 | 90 | 60 | 87 | 45 | 80 | 15 | 75 |
| Residue from distillation to 360°C percent volume by difference | 50 | | 55 | | 67 | | 75 | | 80 | |
| Tests on residue from distillation: Penetration at 25°C, 100g, 5 sec. | 120 | 250 | 120 | 250 | 120 | 250 | 120 | 250 | 120 | 250 |
| *Ductibility at 25°C, mm | 1000 | | 1000 | | 1000 | | 1000 | | 1000 | |
| Solubility in trichloro-ethylene, percent | 99.0 | | 99.0 | | 99.0 | | 99.0 | | 99.0 | |
| Water, percent | | 0.2 | | 0.2 | | 0.2 | | 0.2 | | 0.2 |

*Note: if the ductility at 25°C is less than 1000, the material will be acceptable if its ductibility at 15.5°C is more than 1000 mm.

3. Rapid-Curing Type Liquid Asphalt

| DESIGNATION | RC-70 | | RC-250 | | RC-800 | | RC-3000 | |
|---|---|---|---|---|---|---|---|---|
| REQUIREMENTS | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. |
| Kinematic viscosity at 60°C, cSt. | 70 | 140 | 250 | 500 | 800 | 1600 | 3000 | 6000 |
| Flash point (Cleveland open cup)°C | | | 26.7+ | | 26.7+ | | 26.7+ | |
| Distillation Test: | | | | | | | | |
| Distillate, percent by volume of total distillate to 360°C: | | | | | | | | |
| to 190°C | 10 | | | | | | | |
| to 225°C | 50 | | 35 | | 15 | | | |
| to 260°C | 70 | | 60 | | 45 | | 25 | |
| to 316°C | 85 | | 80 | | 75 | | 70 | |
| Residue from distillation to 360°C, percent volume be difference | 55 | | 65 | | 75 | | 80 | |
| Tests on residue from distillation: | | | | | | | | |
| Penetration at 25°C, 100g. 5 sec. | 80 | 120 | 80 | 120 | 80 | 120 | 80 | 120 |
| *Ductility at 25°C, mm | 1000 | | 1000 | | 1000 | | 1000 | |
| Solubility in trichloroethylene, percent | 99.0 | | 99.0 | | 99.0 | | 99.0 | |
| Water, percent | | 0.2 | | 0.2 | | 0.2 | | 0.2 |

*Note: If the ductility at 25°C is less than 1000, the material will be acceptable if its ductility at 15.5°C is more than 1000 mm.

3.02 Special Primer

| DESIGNATION | MIN. | MAX. |
|---|---|---|
| Kinematic Viscosity at 60°C - Centistokes | 20 | 35 |
| Distillate % by Volume of total distillate to 360°C: | | |
| to 190°C | - | 60 |
| to 225°C | 40 | - |
| to 260°C | 70 | - |
| to 316°C | 85 | - |
| Residue from distillation to 360°C, volume % by difference | 50 | - |
| Tests on residue from distillation to 360°C | | |
| Penetration at 25°C, 100 g, 5 sec. | 80 | 200 |
| *Ductility at 25°C, mm | 1000 | - |
| Solubility in Carbon Tetrachloride | 99.5 | - |
| Water, percent | - | 0.2 |

*NOTE: If the ductility at 25°C is less than 1000, the material will be acceptable if its ductility at 15.5°C is more than 1000 mm.

NOTE: Viscosity of residue from distillation to 360°C will be measured at 60°C and reported in stokes on each batch analysis report.

3.03 Preliminary Specification for Rubberized Cutback Asphalt R.R.C.

a) General Description - Rubberized Cutback Asphalt shall consist of a selected vacuum reduced asphalt containing a matched synthetic rubber, dispersed colloidally or in molecular solution at the refinery, and cutback with naptha solvent to produce a range of cutback material having substantially similar properties to R.C. Cutback, except that the rubberized asphalt residue shall have considerable increased tenacity and toughness characteristics.

b) Tests - The rubberized asphalt residue shall, when tested by the Benson Method and compared with the original asphalt base stock, show a minimum toughness of 200 percent and minimum tenacity of 1000 percent.

c) Acceptance - The acceptance of any rubberized asphaltic material shall be at the sole discretion of the Municipal Engineer.

## 4.0 Emulsified Asphalts

4.01 Types - Liquid bituminous materials in the form of aqueous emulsions shall be of the following:

a) Emulsified Asphalt

1. The emulsified asphalt shall be homogeneous. It shall show no separation of asphalt after thorough mixing within thirty (30) days [crack filler twenty (20) days] after delivery, provided separation has not been caused by freezing.

2. The emulsion shall conform to the detailed requirements of the following table, and the requirements of the A.S.T.M. Specification D-977.

| TYPE | RAPID-SETTING | | | | MEDIUM-SETTING | | | | | | SLOW-SETTING | | | | CRACK FILLER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRADE | RS-1 | | RS-2 | | MS-1 | | MS-2 | | MS-2h | | SS-1 | | SS-1h | | |
| REQUIREMENT | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | |
| Tests on Emulsions: | | | | | | | | | | | | | | | |
| Viscosity, Saybolt Furol at 25°C, s | 20 | 100 | | | 20 | 100 | 100 | | 100 | | 20 | 100 | 20 | 100 | 50-200 |
| Viscosity, Saybolt Furol at 50°C, s | | | 75 | 400 | | | | | | | | | | | |
| Settlement, 5 days, percent | | 5 | | 5 | | 5 | | 5 | | 5 | | 5 | | 5 | 3- |
| Storage stability test, 1 day | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| Demulsibility, 35 ml, 0.02 N CaCl 2, percent | 60 | | 60 | | | | | | | | | | | | |
| Coating ability and water resistance: | | | | | | | | | | | | | | | |
| Coating, dry aggregate | | | | | good | | good | | good | | | | | | |
| Coating after spraying | | | | | fair | | fair | | fair | | | | | | |
| Coating, wet aggregate | | | | | fair | | fair | | fair | | | | | | |
| Coating, after spraying | | | | | fair | | fair | | fair | | | | | | |
| Cement mixing test, percent | | | | | | | | | | | | 2.0 | | 2.0 | |
| Sieve test, percent | | 0.10 | | 0.10 | | 0.10 | | 0.10 | | 0.10 | | 0.10 | | 0.10 | |
| Residue by distillation, percent | 55 | | 63 | | 55 | | 65 | | 65 | | 57 | | 57 | | |
| Tests on Residue from Distillation Test: | | | | | | | | | | | | | | | |
| Penetration, 25°C, 100 g, 5 s | 100 | 200 | 100 | 200 | 100 | 200 | 100 | 200 | 40 | 90 | 100 | 200 | 40 | 90 | 60-100 |
| Ductility, 25°C, 50mm/min, mm | 400 | | 400 | | 400 | | 400 | | 400 | | 400 | | 400 | | |
| Solubility in trichloroethelene, percent | 97.5 | | 97.5 | | 97.5 | | 97.5 | | 97.5 | | 97.5 | | 97.5 | | |

b) Cationic Emulsified Asphalts - Cationic emulsions shall comply with the requirements given in the following tables when tested according to the methods designated with each requirement, and shall comply with the requirements of A.S.T.M. Specification D-2397.

| TYPE | RAPID-SETTING | | | | MEDIUM-SETTING | | | | SLOW-SETTING | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRADE | CRS-1 | | CRS-2 | | CMS-2 | | CMS-2h | | CSS-1 | | CSS-1h | |
| REQUIREMENT | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. |
| Tests on Emulsions: | | | | | | | | | | | | |
| Viscosity, Saybolt Furol at 25°C, s | | | | | | | | | 20 | 100 | 20 | 100 |
| Viscosity, Saybolt Furol at 50°C, s | 20 | 100 | 100 | 400 | 50 | 450 | 50 | 450 | | | | |
| Settlement, 5 days, percent | | 5 | | 5 | | 5 | | 5 | | 5 | | 5 |
| Storage stability test, 1 day percent | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 |
| Classification test | passes | | passes | | | | | | | | | |
| or | | | | | | | | | | | | |
| Demulsibility, 35 ml, 0.8 percent sodium dioctyl sulfosuccinate, percent | 40 | | 40 | | | | | | | | | |
| Coating ability and water resistance: | | | | | | | | | | | | |
| Coating, dry aggregate | | | | | good | | good | | | | | |
| Coating after spraying | | | | | fair | | fair | | | | | |
| Coating, wet aggregate | | | | | fair | | fair | | | | | |
| Coating, after spraying | | | | | fair | | fair | | | | | |
| Particle charge test | positive | | positive | | positive | | positive | | positive | | positive | |
| Sieve test, percent | | 0.10 | | 0.10 | | 0.10 | | 0.10 | | 0.10 | | 0.10 |
| Cement mixing test, percent | | | | | | | | | | 2.0 | | 2.0 |
| Distillation: | | | | | | | | | | | | |
| Oil distillate, by volume of emulsion, percent | | 3 | | 3 | | 12 | | 12 | | | | |
| Residue, percent | 60 | | 65 | | 65 | | 65 | | 57 | | 57 | |
| Tests on Residue from Distillation Test: | | | | | | | | | | | | |
| Penetration, 25°C, 100 g, 5 s | 100 | 250 | 100 | 250 | 100 | 250 | 40 | 90 | 100 | 250 | 40 | 90 |
| Ductility, 25°C, 50mm/min, mm | 400 | | 400 | | 400 | | 400 | | 400 | | 400 | |
| Solubility in trichloroethelene, percent | 97.5 | | 97.5 | | 97.5 | | 97.5 | | 97.5 | | 97.5 | |

TABLE #2

| Grade: | RS-1K | | RS-2K | |
|---|---|---|---|---|
| Requirement: | Min. | Max. | Min. | Max. |
| Saybolt Furol Viscosity at 50°C | 30 | 125 | 174 | 400 |
| % Residue by Distillation | 62 | - | 68 | - |
| Settlement 1 day, % | - | 1.5 | - | 1.5 |
| Sieve Test, % retained on 1 mm mesh | - | 0.1 | - | 0.1 |
| Oil Portion of Distillate, % of total volume | 0 | 3 | 0 | 3 |
| Particle Charge | Positive | | Positive | |
| Tests on Residue: | | | | |
| Penetration @ 25°C, 100g/5s | 100 | 250 | 100 | 150 |
| Solubility in Trichloroethylene, % | 97.5 | - | 97.5 | - |
| Ductility (cm) @ 25°C | 60 | - | 65 | - |

c) High Float Emulsified Asphalt

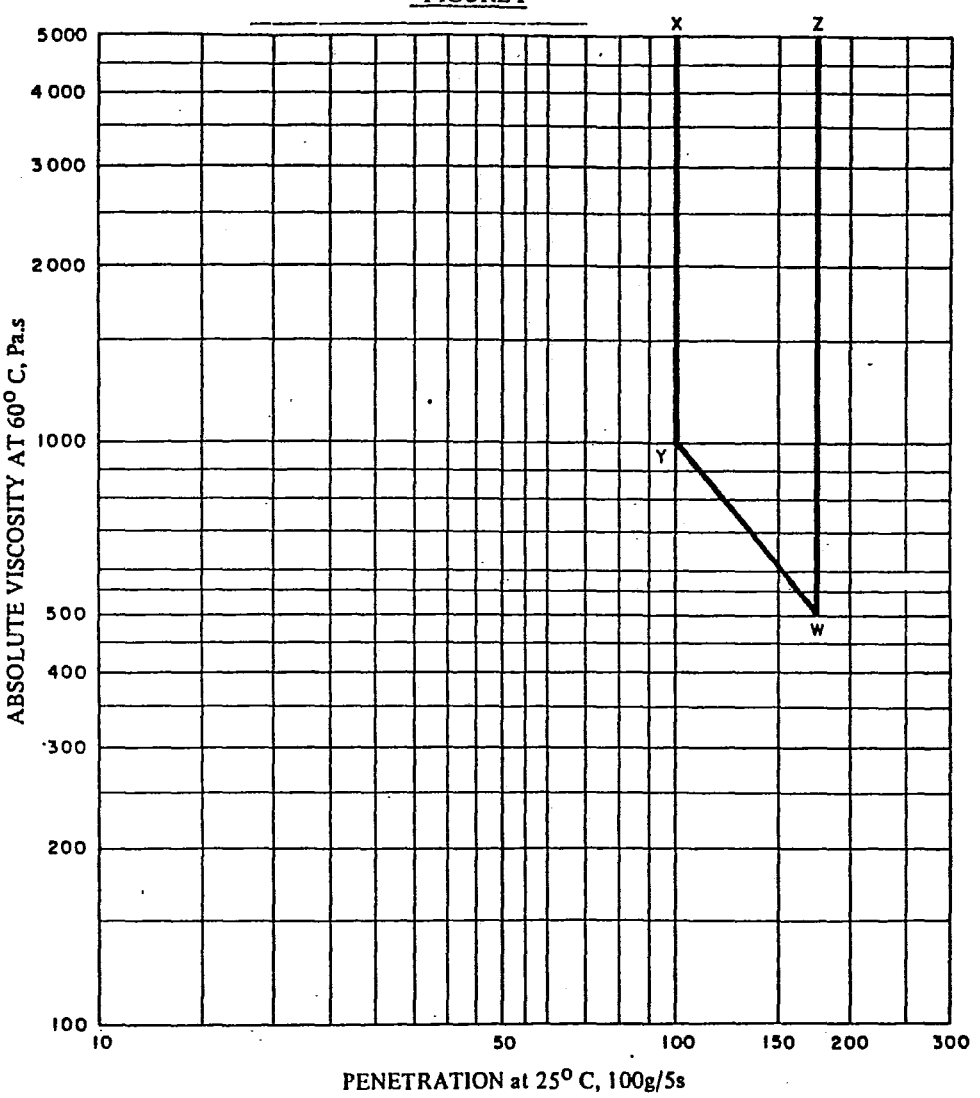
Storage stability - High float emulsified asphalt shall show no separation of asphalt within 30 days after delivery and shall be homogeneous after thorough mixing.

| Grade: / Requirements | HF-100S | | HF-150S | | HF-250S | | HF-350S | | HF-500M | | HF-1000M | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| Residue by Distillation, % by Mass | 62 | - | 62 | - | 62 | - | 65 | - | 65 | - | 65 | - |
| Oil Distillate % By Volume | 1 | 4 | 0.5 | 4 | 1 | 6 | 1.5 | 6 | 1 | 6 | 1 | 7 |
| Saybolt Viscosity, Furol Seconds at 50°C | 35 | 150 | 35 | 150 | 35 | 150 | 75 | 400 | 50 | - | 50 | - |
| Sieve Test, % Retained on 1 mm Sieve | - | 0.10 | - | 0.10 | - | 0.10 | - | 0.10 | - | 0.10 | - | 0.10 |
| Coating Test % | 90 | - | 90 | - | 90 | - | | | | | | |
| Settlement 1 day, % by Mass | - | 1.5 | - | 1.5 | - | 1.5 | - | 1.5 | - | 1.5 | - | 1.5 |
| Demulsibility: 50 ml 5.55 g/L $CaCl_2$, % by Mass | 75 | - | 75 | - | - | - | - | - | - | - | - | - |
| Workability @ 10°C | - | - | - | - | - | - | - | - | - | - | Pass | - |
| Test on Residue | | | | | | | | | | | | |
| Penetration at 25°C, 100 g/5s | * | | ** | | ** | | ** | | - | - | - | - |
| Viscosity at 60°C, Pa/s | * | | ** | | ** | | ** | | 8 | 20 | 2 | 8 |
| Float Test at 60°C,s | 1200 | - | 1200 | - | 1200 | - | 1200 | - | 1200 | - | 1200 | - |
| Solubility in Trichloroethylene, % | 97.5 | - | 97.5 | - | 97.5 | - | 97.5 | - | 97.5 | - | 97.5 | - |

* See Figure I - Next Page
** See Figure II - Following

C) - High Float Emulsified Asphalt (cont'd)

FIGURE I




VISCOSITY REQUIREMENTS FOR DISTILLATION RESIDUES FROM

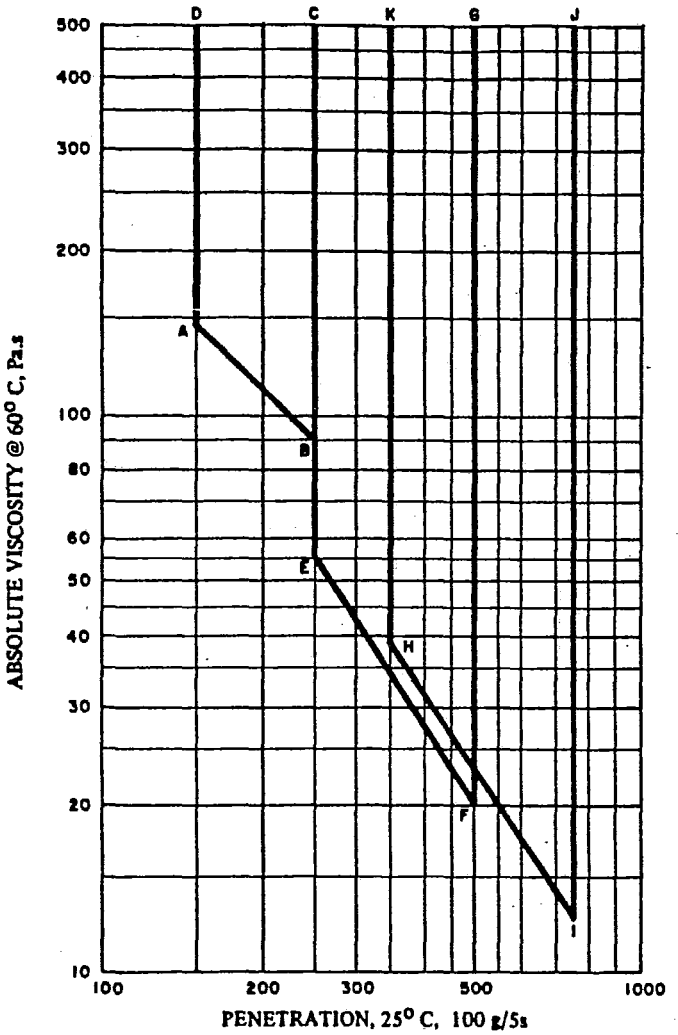
HIGH FLOAT EMULSIFIED ASPHALT, HF-100S

Viscosity shall be within graphic regions described by the letter co-ordinates X, Y, W, Z.

# DISTRICT OF SAANICH SPECIFICATION

C) - High Float Emulsified Asphalt (cont'd)

FIGURE II




| Gradation of High Float Emulsified Asphalt | HF-150S | HF-250S | HF-350S |
|---|---|---|---|
| Viscosity and Penetration shall be within graphic regions described by the letter co-ordinates | A, B, C, D | E, F, G, C | H, I J, K |

1.0 Scope

1.01 General

a) This specification describes the materials, equipment and the workmanship required for construction of granular surfacing, bases and sub-bases, using crushed granular or pit-run aggregates.

b) This specification shall be read and construed with the Special Provisions of the Contract prepared by the Consulting or Municipal Engineer, and the approved Design Drawing.

1.02 Description of Work - The aggregates for granular surfacing, bases and sub-bases shall be supplied by the Contractor. All materials shall be from an approved source and shall be free from lumps of clay, silt, decomposed rock, organic or other deleterious matter. Material that is stock-piled prior to use shall be handled in a manner to avoid segregation. Such care shall be used subsequently in hauling to the area of placement of the material. The material shall be placed, constructed accurately, and thoroughly compacted to the line and grade designated. Surfacing aggregate intended for surface-stabilization to be done in place on the the road, shall be placed on the untreated base only as fast as it can be incorporated in the road mixed stabilizer base. Unless otherwise provided in the Special Provisions, the Contractor shall maintain the prepared surface of the untreated surfacing, until it has been treated or covered with stabilized surface material.

2.01 Materials

2.01 Aggregates shall be composed of inert, durable fragments, free from an excess of flat or elongated particles, and uniform in quality. Soundness testing may be requested by the Consulting Engineer in the absence of satisfactory performance records for the aggregates particular source. Such testing shall be in accordance with A.S.T.M. Specification C88, using Magnesium Sulphate. Aggregates so tested, shall be considered satisfactory, if the loss of five (5) cycles does not exceed twenty (20) percent for coarse aggregate or twenty-five (25) percent for fine aggregate.

2.02 Crushed Surfacing, Crushed Pit-Run and Pit Run

a) Crushed surfacing, crushed pit-run and pit-run and when tested in accordance with A.S.T.M. Specification C136 shall have a gradation falling within the following limits.

| MATERIAL DESCRIPTION | | PERCENTAGE PASSING - EACH TYPE OF AGGREGATE | | |
|---|---|---|---|---|
| Aggregate size: | | 20 mm | 80 mm | 80 mm |
| Type of aggregate: | | crushed | crushed pit-run | pit-run |
| Aggregate use: | | surfacing | base course | sub-base |
| U.S. Standard Sieve Size | CGSB 8-GP-2M Sieve Size | | | |
| 3" | 80 mm | - | 100- | 100 |
| 1 1/2" | 40 mm | - | 60-100 | - |
| 3/4" | 19 mm | 100 | 40- 80 | 15-100 |
| 3/8" | 9.5 mm | 60-100 | 30- 60 | 0-100 |
| No. 4 | 4.75 mm | 40- 80 | 20- 45 | 0-100 |
| No. 8 | 2.36 mm | 30- 60 | 15- 35 | - |
| No. 16 | 1.18 mm | 20- 45 | 10- 25 | - |
| No. 50 | 300 um | 8- 20 | 4- 16 | 0- 15 |
| No. 100 | 150 um | - | - | - |
| No. 200 | 75 um | 2- 9 | 2- 9 | 0- 5 |

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b) Should the Contractor supply aggregate with a gradation coarser than paragraph 2.02 a), and can satisfy the Consulting Engineer that the compaction and stability requirements can be met, the Engineer may direct, in writing, that such aggregate may be used.

c) In the crushed material, at least fifty (50) percent by numerical count of all coarse particles retained on the 4.75 mm sieve shall have at least one fractured face or shall be naturally angular with sharp edges.

3.0 Construction Method

3.01 Weather and Job Conditions

a) No construction shall be undertaken during heavy rain, snow or freezing conditions.

b) Granular aggregate shall not be placed upon a frozen, wet, muddy or rutted sub-grade, sub-base, or surface, unless directed by the Engineer, in writing.

c) When the sub-grade or base is soft due to excessive moisture conditions, granular materials shall be hauled and placed, such that no rutting or displacement of lower layers occurs.

3.02 Construction Thickness of Granular Courses

a) Crushed granular surface course, and crushed granular or pit-run base course and sub-base courses shall be constructed to the thickness and dimensions as shown in the Design Drawing or described in the Special Provisions, unless otherwise directed by the Consulting Engineer, in writing.

b) Aggregates shall be delivered to the road bed as uniform mixtures and shall be spread in layers or windrows without segragation. Granular aggregate shall not be end-dumped from trucks and piled on the road bed.

c) When the subgrade consists of cohesionless material, the Consulting Engineer may approve in writing, that granular sub-base or base may be dumped in piles and spread in sufficient quantity to stabilize the sub-grade.

d) Fly spreading from the tailgate of trucks may be permitted by the Consulting Engineer, provided that the work is well controlled and that no segregation will occur. Any segregation of materials shall be remixed until uniform.

e) Surfacing materials shall only be laid on a dry base and when weather conditions are suitable, except as directed by the Consulting Engineer.

3.03 Construction of Crushed Granular Base or Pit-Run Sub-Base

a) Where the required thickness is 150 mm or less, the aggregate base or sub-base may be spread and compacted in one (1) layer. Where the required thickness is more than 150 mm, the aggregate shall be spread and compacted in two (2) or more layers of equal thickness: the maximum compacted thickness of any one (1) layer shall not exceed 150 mm. Each layer shall be spread and compacted in a similar manner.

b) Following spreading, the materials shall be compacted to 95% of the labratory density obtained by following A.S.T.M. Specification 698, Method C, or latest revision thereof with exception of the top 300 mm which shall be compacted to 100%.

c) The sub-base or base shall be constructed so that the final surface shall conform to the Design Drawing for line, grade and cross-section, or as staked by the Consulting Engineer to an accuracy of ± 15 mm.

3.04 Construction of 20 mm Crushed Granular Surfacing

a) Crushed granular surfacing shall not be spread until the base has been approved by the Consulting Engineer. If the Consulting Engineer is of the opinion that the finished surface of the base does not meet the requirements of paragraph 3.03 c) but has been thoroughly and densely compacted and should not be disturbed, he may order that the surface of the base be corrected to true cross-section line and grade, within the specified tolerances, by use of a leveling course of 20 mm granular surfacing aggregate.

b) The surfacing aggregate shall be spread in such a manner that the aggregate does not segregate. The thickness of the surfacing shall be uniform and the minimum thickness of the constructed surfacing aggregate shall be not less than the nominal thickness shown in Municipal Standard Drawings R-1, R-2, R-3, and R-4.

c) Following spreading, the material shall be compacted to one-hundred (100) percent of the density obtained in the laboratory in accordance with A.S.T.M. Specification D698 - Method D.

d) The sub-base or base shall be constructed so that the final surface shall conform to Municipal Standard Drawings R-1, R-2, R-3, and R-4 for line, grade, and cross-section, to an accuracy of ± 10 mm.

3.05 Compaction Method and Equipment

a) The compaction and equipment used to obtain the specified density, may be selected by the Contractor, but will be subject to review or alteration by the Consulting Engineer, if the Contractor is unable to attain the desired density.

b) For the purpose of the compaction requirements of paragraphs 3.03 b) and 3.04 c), compaction equipment shall meet the following minimum requirements.

1. Three wheel steel rollers shall have a loaded mass of not less than 10.9 tonnes, with a compression at the rear wheels of not less than 60.0 N/mm of width.

2. Segmented steel wheel rollers shall have two rolls side by side each of a minimum width of 750 mm and minimum diameter of 1500 mm. The minimum loaded rolling mass shall be 13.6 tonnes.

3. Vibratory rollers shall have a minimum steel drum diameter of 1150 mm, a minimum drum width of 1500 mm and shall be capable of being loaded so as to have a load of 17.5 N/mm of drum width.

4. Pneumatic tired rollers shall be equipped with wheels which carry 13.00 x 24 pneumatic tires capable of being inflated to a minimum pressure of 825 kPa, and shall have a loaded mass such that all wheels carry a minimum proportional load of 31.14 kN.

c) Notwithstanding paragraph 3.05 b), the Consulting or Municipal Engineer may give approval for the use of new or alternative compaction equipment, if he is satisfied that such equipment will provide equal or superior compaction performance.

d) Subject to the approval of the Consulting Engineer, base, sub-base and surfacing aggregates may be watered by the Contractor, as required to aid in attaining the specified density.

## 1.0 General

1.01 All contact surfaces that are to receive asphaltic concrete paving shall be prepared as set out in this Specification. Surface preparation may be generally described as being either priming of non-asphaltic granular bases or tack-coating of existing asphaltic pavement, which are to receive an overlying surfacing course.

## 2.0 Materials

2.01 Prime or tack-coat asphalts shall be those speficied by the Municipal Engineer. The asphalt specified shall conform to Appendix 1 - Asphaltic Materials.

## 3.0 Equipment

3.01 Rotary Power Brooms shall be used for all brooming work. The brooms shall be mounted on self-propelled pneumatic-tired tractor units, and shall be capable of vertical adjustment and shall have sufficient power and brushing capacity to completely clean the surface to be paved within three (3) coverages. Hand brooms shall be used to clean all depressions not reached by the rotary broom.

3.02 Pressure Distributors shall be designed and operated to distribute the asphaltic material in a uniform spray without atomization, in the amount and between the limits of temperature specified.

a) It shall be equipped with a bitumeter having a dial registering metres per minute. The dial shall be visible to the truck driver so he can maintain the constant speed required for application at the specified rate.

b) The pump shall be equipped with a tachometer, having a dial registering litres per second passing through the nozzles. The dial shall be readily visible to the operator.

c) Means for indicating accurately the temperature of the asphaltic material at all times shall be provided. The thermometer well shall not be in contact with a heating tube.

d) The normal width of application of the spray bar shall be not less than 3.5 m, with provisions for the application of lesser width when necessary. A hose and spray nozzle attachment shall be provided for applying asphaltic material to patches and areas inaccessible to the spray bar.

e) The distributor shall be provided with heating attachments and the asphaltic material shall be circulated during the entire heating process.

## 4.0 Cleaning of Surfaces

4.01 All surfaces, both horizontal and vertical, which will be in contact with the new asphalt mix shall be thoroughly cleaned of all dirt and debris. Cleaning will normally be done using rotary brooms and hand brooms, however, washing or flushing may be necessary to remove coatings of clay or dirt on old pavement.

## 5.0 Preparation of Vertical Surfaces

5.01 Vertical faces of existing pavements, curbs, gutters, drainage gratings, manholes, or other contact surfaces shall be sprayed or painted with a uniform coating of hot asphalt or asphalt emulsion. Sufficient material shall be used to provide closely bonded water-tight joints. This work shall be done in such a way as to not stain exposed curb or gutter surfaces.

6.0 Priming Non-Asphalt Base

6.01 Prior to priming, the granular base, unless constructed by the paving contractor immediately prior to paving, shall be prepared by blading, dragging, spraying with water and compacting with rollers as required, so as to provide a uniform tight compacted surface, correct to line, grade, and crown or superelevation. All surplus loose aggregate shall be bladed clear on the shoulders for use in shouldering. Care shall be exercised in removing loose aggregate, to guard disturbing the bond of the aggregate in the surface of the base.

6.02 Asphaltic priming shall take place when the granular base is dry or slightly damp and the ambient temperatures are over 10°C.

6.03 The selected asphaltic primer shall be uniformly sprayed by an approved distributor at the rate specified by the Consultant Engineer.

6.04 The primer shall be sprayed within a temperature range which will cause the kinematic viscosity to be between fifty (50) and one hundred and fifty (150) centistokes.

6.05 Care shall be exercised, however, to prevent over-priming. Prime that is not absorbed into the base within twenty-four (24) hours after application, or over-priming, shall be corrected by the application of selected cover sand.

6.06 Any spraying faults shall be corrected by hand spraying, brooming or the subsequent removal of cover sand placed on over-primed areas. The asphaltic primer shall be entirely absorbed by the base course.

6.07 All traffic, where possible, shall be kept off the prime base until the primer has been absorbed. Where it is not possible to keep traffic off wet primer, the surface shall be blinded with a cover sand or fine aggregate.

6.08 The Contractor shall maintain the base as may be necesary to keep the surface prime intact.

7.0 Tack Coating of Existing Asphaltic Pavements

7.01 Prior to tack coating, deficiencies in the existing pavement shall be treated as follows:

a) Joints and cracks, 15 mm or more in width, should have the existing filler removed to a depth of at least 25 mm. They shall be refilled with a dense, fine-graded mixture thoroughly tamped into place. Any excess shall be removed level with the pavement surface.

b) Rigid-type pavements that have transverse pre-molded expansion and longitudinal joints shall be cleaned out to a depth of 50 mm and refilled as noted in paragrapgh 7.01 a).

c) Asphalt patches which appear to contain an excess of asphalt or may appear to be unstable shall be removed from the pavement.

d) Surface cracks wider than 5 mm shall be treated as in paragrapgh 7.01 a).

e) Surface cracks less than 5 mm in width shall be treated with the same asphaltic material as used in the tack coat.

7.02 After all repairs have been completed, the surface shall be cleaned as noted in paragraph 4.01 immediately prior to application of the tack coat.

7.03 Tack coating shall take place when the ambient temperature is over 10° C.

7.04 The selected asphaltic tack coat shall be uniformly sprayed by an approved distributor at the rate specified by the Consultant Engineer.

7.05 Extreme care shall be exercised in the application of the tack coat so as to avoid a surplus of asphalt which may flush into the overlying course.

7.06 In places where the distributor bars cannot reach, the tack coat shall be applied with a hand sprayer attached to the distributor by a hose. When hand spray methods are used, care shall be taken to avoid over-coating of the surface.

7.07 No more tack coat than is necessary for the day's operation shall be places on the surface. All traffic not essential to the work shall be kept off the tack coat.

## 1.0 Scope

### 1.01 General

a) This Specification describes the materials, plant equipment and workmanship required for the construction of hot mixed, hot laid asphaltic concrete pavement.

b) This Specification shall be read and construed with the Special Provisions of the Contract, (prepared by the Consulting or Municipal Engineer and the approved Design Drawing).

### 1.02 Description of Work

Under this Specification, asphaltic concrete consisting of mineral aggregate and asphaltic binder, shall be combined and hot mixed in an approved mixing plant, spread on a prepared base and compacted to an approved density, all as shall be described in this Specification.

### 1.03 Pavement Types and Design Criteria

a) There shall be three (3) types of mixes for pavement construction:

1) Coarse Mix, for base and surface courses where specified.

2) Medium Mix, which shall be the normal mix for pavement construction.

3) Fine Mix, for light surface courses and special levelling purposes.

b) There shall also be three (3) strength classifications for asphaltic concrete pavement, based on design traffic criteria in accordance with The Asphalt Institute Specification Series No. 1 (SS-1) Manual:

Class A - Light Traffic Classification - Residential Road
Class B - Medium Traffic Classification - Collector Road
Class C - Heavy Traffic Classification - Major Road

Mixes for each class of pavement shall meet Marshall Test design criteria as specified in the following table.

c) The type and class of pavement required shall be specified by the Municipal Engineer.

| PROPERTY OF LABORATORY COMPACTED PAVING MIXTURE | PAVEMENT CLASS A | B | C |
|---|---|---|---|
| Number of flows each face of test specimen | 35 | 50 | 75 |
| Stability, all mixtures, N. | 2250 | 2250 | 3350 |
| Flow index, all mixtures, units of 0.25 mm | 8-20 | 8-18 | 8-16 |
| Percent Air Voids | | | |
| Surface or leveling course | 3-5 | 3-5 | 3-5 |
| Base course | 3-8 | 3-8 | 3-8 |
| Minimum Percent Voids in Mineral Aggregate for nominal maximum particle size | | | |
| 20 mm | 14 | 14 | 14 |
| 15 mm | 15 | 15 | 15 |
| 10 mm | 16 | 16 | 16 |
| Minimum index of retained stability after immersion in water at 60°C for 24 hours. | 80% | 80% | 80% |

d) Mixes shall be designated as to mix type number followed by class strength classification. Thus, coarse mixes will be designated as Mix 1A, Mix 1B, and Mix 1C. Medium mixes will be designated as Mix 2A, Mix 2B, and Mix 2C. Fine mixes will be designated as Mix 3A, Mix 3B, and Mix 3C.

1.04 Final compaction Requirements

a) If required by the Municipal Engineer, cores will be drilled from the road surface after final rolling is completed. The cores shall be used to measure thickness of the pavement and to test the density of the compacted mix, as required under paragraph 1.04 b).

b) The compacted asphalt concrete pavement shall have a density equal to or greater than ninety-seven (97) percent of a laboratory specimen prepared by the Marshall Test Method in accordance with paragraph 1.03 b), from a sample taken from a truck delivering the mixture on the job site. The laboratory density shall be compared with the filed density at the location of the same truckload mixture from which the laboratory specimen was made.

c) The compacted base and surface course shall have average thickness no less than that specified by the approval Design Drawings. Any deficiency in base course thickness shall be made up with surface mixtures when the surface course is placed.

2.0 Materials

2.01 Methods of Test

a) Asphaltic materials shall be tested in accordance with methods of test designated on Appendix 7 - Methods of Test.

b) Mineral aggregates shall be tested in accordance with methods of test designated in Appendix 7 - Methods of Test.

2.02 Asphaltic Material

a) Asphaltic cement to be used in preparation of asphaltic concrete paving mixture shall be penetrating asphalt as described under Appendix 1 - Asphaltic Materials and of the grade specified in the Special Provisions. Such material shall at no time be heated to a temperature in excess of that which will cause the material to have a kinematic viscosity of less than one-hundred (100) centistokes.

b) The bitumous cement content of the mix as determined by the Engineer shall not vary from the selected job mix content by more than ± 0.3 percent by mass of the total mix.

2.03 Coarse Aggregate

a) For purpose of standard A.S.T.M. tests, coarse aggregate shall be all mineral material retained on the 4.75 mm sieve. It shall consists of crushed stone, crushed slag, crushed gravel or combinations thereof, or materials naturally occurring in a fractured condition or of a highly angular natural aggregate with pitted or rough surface texture.

b) The coarse aggregate other than slag or naturally occurring rough textured or pitted surface aggregate shall contain at least sixty (60) percent by mass of crushed pieces having two (2) or more surfaces or faces produced by fracture, when the aggregate is required for incorporation in mixes to be used in construction of pavements, types B or C.

c) Aggregate having known polishing characteristics shall not be used in surface coarse mixes except by express permission of the Municipal Engineer.

d) The maximum absorption of the coarse aggregate when tested in accordance with A.S.T.M. Designation C127 shall be 1.7 percent.

e) All coarse aggregate shall be free from coatings of clay, silt, or other objectionable matter and shall not contain more than 1.5 percent by mass of clay balls or other aggregations of fine material.

f) Coarse aggregate shall be tested for soundness in accordance with A.S.T.M. Specification C88 for which maximum weighted losses for five (5) cycles shall be eighteen (18) percent when magnesium sulphate is used.

g) Crushed slag shall meet the requirements of A.S.T.M. Specification D693.

2.04 Fine Aggregate

a) For purposes of standard A.S.T.M. test, fine aggregate shall be all mineral matter passing the 4.75 mm sieve including mineral fillers. It shall consist of natural and/or manufactured material derived by crushed stone, slag, or gravel.

b) The aggregate particles shall be clean, tough, durable, moderately sharp and free from coating of clay, silt, or other objectionable matter, and shall contain no clay balls or other aggregations of fine material.

c) Fine aggregate shall be tested for soundness by A.S.T.M. Specification C88 for which maximum weighted losses for five (5) cycles shall be twenty (20) percent when magnesium sulphate is used.

2.05 Mineral Filler

a) Mineral filler shall consist of all mineral matter which will pass the No. 200 sieve.

b) Mineral filler may consist of fine particles of the coarse or fine aggregate or of finely ground particles of limestone, hydrated lime, Portland Cement, or other selected mineral matter. It shall be dry, free from organic matter, clay particles or lumps.

c) Mineral filler shall be non-plastic when tested by A.S.T.M. Specification D-423 and D-424.

2.06 Paving Mixes

a) Paving mixes prepared under these Specifications shall be composed of aggregates and paving asphalt meeting the requirements of the following table:

| U.S. Standard | CGSB 8-GP-2M | Percentage Passing for Each Mix Type | | |
|---|---|---|---|---|
| Sieve Size | Sieve Size | Coarse | Medium | Fine |
| 3/4" | 19 mm | 100 | | |
| 1/2" | 13.2 mm | 80-100 | 100 | |
| 3/8" | 9.5 mm | 70- 90 | 80-100 | 100 |
| No. 4 | 4.75 mm | 50- 70 | 55- 75 | 30-100 |
| No. 8 | 2.36 mm | 35- 54 | 35- 57 | 64- 89 |
| No. 16 | 1.18 mm | 26- 42 | 26- 44 | 48- 76 |
| No. 30 | 600 µm | 18- 32 | 18- 32 | 32- 60 |
| No. 50 | 300 µm | 13- 24 | 13- 23 | 16- 42 |
| No.100 | 150 µm | 8- 16 | 8- 16 | 6- 23 |
| No.200 | 75 µm | 2- 8 | 4- 10 | 4- 10 |

b) However, should the Contractor provide an aggregate which will meet the overall maximum size and design requirements of paragraph 1.03, other than Index of Retained Stability After Immersion in Water, such aggregate may be accepted upon approval of the Engineer, notwithstanding the fact that its grading curve does not fall within the limits prescribed in the above table.

c) If sieve test results indicate that variations in aggregate gradation are exceeding the maximum permissible limits detailed above, the Contractor shall immediately modify his aggregate production procedure to the satisfaction of the Consulting Engineer so as to produce aggregate having a gradation which will consistently fall within the permissible limits specified. Aggregate produced during periods when gradation is out of control may be rejected by the Consulting Engineer and shall be removed or otherwise disposed of as may be directed.

3.0 Plant and Equipment

3.01 Paving Plant Essentials

a) The plant used by the Contractor for the preparation of hot mix asphaltic concrete material shall conform to the requirements for mixing plants for hot mix, hot-laid bituminous paving mixtures, A.S.T.M. Specification D995 and to the recommended procedures of the Asphalt Institute's, "Asphalt Plant Manual" Manual Series No. 3 (MS-3).

b) The plant shall be so designed and co-ordinated as to produce a uniform mixture within the Specifications.

3.02 Control of Mixing Temperatures

a) The mixing temperature for a particular asphaltic concrete mix shall be that which corresponds to a viscosity range of 150 to 300 centistokes (75 to 150 seconds Saybolt Furol) for the asphalt cement penetration grade specified in the Special Provision. Mixing temperatures generally shall conform to the recommended temperatures of the Asphalt Institute. At no time shall the maximum mixing temperature exceed 176°C. The lowest possible temperature consistent with paragraph 3.02 b) should be used.

b) Mixing temperature shall be consistent with paragraph 3.03 to provide uniform coating of asphalt on all aggregate particles.

3.03 Control of Mixing Time

Mixing time shall be the minimum required to obtain a uniform distribution of aggregate sizes and a uniform coating of asphalt on all aggregate particles. The minimum mixing time shall be that which produces a Ross Count of:

1. 90 percent fully coated for base mixes
2. 95 percent fully coated for surface mixes

as determined by the Ross Count Procedure. The least time needed for the pugmill to produce mixes meeting the minimum coating requirements shall be the minimum mixing time.

3.04 Transporting the Mixture

a) Trucks used to haul the asphalt paving mixture from the plant to the job site shall be in good mechanical condition at all times. Truck bodies that come in contact with the asphalt mixture should be clean and smooth and free from cracks, holes, dents, and shall be clean of all foreign material.

b) Surfaces of the truck coming in contact with the asphalt paving mixture may be lubricated with either a mild lime water, a soap, or detergent solution, or an approved commercial solvent in emulsion form suitably diluted as recommended by the manufacturer. After the solution has been painted or sprayed on, the truck beds should be elevated so the excess can drain out. Oil, grease and other similar products shall not be permitted.

c) A canvas or similar covering shall be used to cover the hot mix after loading into the truck regardless of the ambient temperature or haul distance. Hauling trucks in which frame-contact, or bed-bearing with the paver during dumping operation shall not be used.

d) Any load with a paving mix temperature of less than 120° C will be rejected. The lowest acceptable mix temperature may only be varied upon the approval of the Engineer.

e) No load shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight unless artificial light, satisfactory to the Engineer, is provided.

## 4.0 Asphaltic Concrete Paving

### 4.01 Base Preparation

No asphalt paving mixture shall be placed on a base that has not been either primed or tack-coated in accordance with the Specifications and in accordance with Appendix 3 - Surface Preparation for Asphaltic Paving.

### 4.02 Paving Equipment

a) Unless otherwise specified, all plant-mixed bituminous mixtures shall be spread by means of mechanical self-powered pavers capable of spreading the mix true to the line, grade and crown indicated on the approved Design Drawing.

b) At the forward end of the machine there shall be hoppers of sufficient capacity to enable the paver to spread the paving mixture continuously and without interruption during the dumping cycle of the haulage trucks. The paving mixture shall be transferred from the hoppers to reversing type distributing screws, designed to distribute the paving mixture evenly and without segregation, across the full laying with of the paver screeds.

c) The paver shall be equipped with an activated screed which shall be adjustable as to level and section. A dampened dial level shall be fitted to the machine so that proper pavement crown or cross fall can be produced throughout the finishing operation.

d) The paver shall be fitted with mechanical devices such as equalizing or straight edge runner, or evener arms or such other compensating devices to prevent minor change in sub-grade elevation from being reflected in the finished surface.

### 4.03 Placing the Mixture

a) Asphalt paving mixtures shall only be laid upon a base, and under weather conditions, approved by the Consulting Engineer. The surface of the base shall be dry. Prior to delivery of the mixture, the prepared base shall be cleaned of all loose or foreign material.

b) Asphalt paving mixture shall only be laid when the ambient temperature is above 5°C and rising.

c) The mixture shall be spread and tamped to the necessary thickness. The paver feed shall be so adjusted to the rate of delivery of the asphaltic mixture, that the paver shall spread mixture at a constant speed and with a minimum of stoppages.

d) The paving mixture shall be spread at the lowest speed compatible with the rate of supply of the paving mixture. The road speed of the paver shall not exceed ten (10) metres per minute for base course mixtures or eight (8) metres per minute for surface course mixtures without the express permission of the Consulting Engineer.

e) Following screeding and prior to roller compaction, the surface shall be checked and any irregularities such as fatty accumulations or other non-uniform surface texture, shall be adjusted. Crooked edges on the paving mat shall be straightened by either removing and wasting mix which bows outside the edge line or by adding mix from the hopper if the edge of the mat is indented, before the edge is rolled.

f) In places inaccessible to a paving machine, handspreading will be permitted. Placing and spreading by hand shall be done very carefully and the material distributed uniformly so that segregation of the coarse aggregate and asphaltic mortar will be avoided. The asphaltic mix shall be distributed into place using hot shovels and shall be spread with hot rakes in a loose layer of uniform density and correct depth. Asphaltic paving mixture for hand spreading shall not be dumped any faster than can be handled by shovelling and raking.

4.04 Joints

Longitudinal and transverse joints shall be carefully prepared, bonded and sealed.

a) Transverse Joints in both base and surface courses, shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight-edged to assure smoothness and true alignment. If a bulkhead was not used to form a transverse joint, the line of the joint shall be located a sufficient distance back of the rounded edge, to provide a true surface and cross section. Where material is trimmed, a neat and vertical face shall be prepared and this face shall be sprayed or painted with a thin uniform coat of hot asphalt cement, or other asphaltic bonding material as may be directed by the Consulting Engineer.

b) Transverse joints made next to an adjoining lane shall be rolled initially by making a pass along the longitudinal joint for a few metres. The surface shall be checked with a straight-edge and corrections made if necessary. The joint shall then be rolled transversely, with the roller on the previously laid material except for a 150 mm projection of the wheels on the freshly laid material. This procedure shall be repeated with successive passes each covering 150 to 200 mm of fresh material until the entire width of a drive roll is on the new mix. Boards of proper thickness should be placed at the edge of the pavement to provide for off-pavement movement of the roller. Where this is impractical, transverse rolling shall stop 150 to 200 mm short of the outside edge of the pavement, and the outside edge shall be rolled out during longitudinal rolling.

c) Longitudinal Joints shall be planned to provide an offset of at least 150 mm from like joints in a previously laid course. The first lane placed shall be true to line and grade and have a near vertical face. Before compaction, the material along unsupported edges shall be butted and slightly elevated with a tamping tool or lute, to set up the edge. Longitudinal edges of a previously laid pavement shall be trimmed to provide a vertical face and this face shall be sprayed or painted with a thin uniform coat of hot asphalt cement, or other asphaltic bonding material as may be directed by the Consulting Engineer.

d) When paving is done against an abutting lane, the paver shall be positioned so that in spreading, the new mix overlaps the compacted lane of pavement by no more than 75 mm. Coarse aggregate in the material overlapping the cold joint shall be carefully removed and wasted. If another course is to be placed over the course being spread, the excess coarse aggregate may be spread over the unrolled lane with a broom or lute. When placing a surface course, excess coarse aggregate shall not be spread over the freshly laid mat.

e) Longitudinal joints shall be rolled directly behind the paving operation. Rolling of joints shall be done with the roller wheels positioned on the previously laid pavement so not more than 150 mm of the rear roller wheel rides on the freshly laid mix. The roller shall continue to roll this line, gradually shifting its position across the joint, until a thoroughly compacted and neat joint is obtained.

## 5.0 Compaction

### 5.01 General

Compaction of freshly laid asphaltic concrete shall be such that the final compaction requirements of paragraph 1.04 are satisfied and that the finished pavement shall be smooth and accurate to the established grade and crown.

### 5.02 Surface

The surface of the finished pavement shall be free from objectionable paver ripple and from lumps or depressions exceeding 5 mm from a 3 m straight edge laid thereon parallel to the centre line or a camber board laid transversely.

### 5.03 Compaction Method and Equipment

a) The method of compaction to obtain the specified density, may be selected by the Contractor, but shall be subject top approval by the Consulting Engineer. The equipment should meet the following minimum requirements.

1. Three wheel steel rollers shall have a loaded weight of not less than 10.9 tonnes, with a compression at the rear wheels of not less than 60 N/mm of width.

2. Steel wheel or segmented steel wheel rollers shall have two rolls side by side each of a minimum width of 750 mm and minimum diameter of 1500 mm. The minimum loaded rolling mass shall be 13.6 tonnes.

3. Vibratory rollers shall have a minimum steel drum diameter of 1150 mm, a minimum drum width of 1500 mm and shall be capable of being loaded so as to have a loaded mass of 17.5 N/mm of drum width.

4. Pneumatic tired rollers shall be equipped with wheels which carry 13.00 x 24 pneumatic tires capable of being inflated to a minimum pressure of 825 kPa and shall have a loaded mass such that all wheels carry a minimum proportional load of 31 kN.

b) For pneumatic tired rollers, tire contact pressures shall be as high as possible without causing displacement of the mix that cannot be remedied in the final rolling. The use of a small amount of non-foaming detergent or water-soluble oils on the wetting mat of the pneumatic-tired rollers at the beginning of the rolling operation will be most helpful in preventing the asphalt from sticking to the tires until they warm up.

c) During rolling, the roller wheels should be kept moist with only enough water to avoid picking up the material. Rollers should move at a slow but uniform speed with the drive roll or wheels nearest the paver. The speed should not exceed 5 km/h for steel wheeled rollers, or 8 km/h for pneumatic-tired rollers. Rollers should be in good condition, capable of being reversed without backlash. The line of rolling should not be suddenly changed or the direction of rolling suddenly reversed, thereby displacing the mix. Any pronounced change in direction of the roller should be made on stable material, the affected areas should be loosened at once with lutes or rakes and restored to the original grade with loose material before being re-rolled. Heavy equipment, including rollers, should not be permitted to stand on the finished surface before it has thoroughly cooled or set.

5.04 Rolling Procedure

a) When paving in single width, the first lane placed shall be rolled in the following order:

1. Transverse joints
2. Outside edge
3. Initial or breakdown rolling, beginning on the low side and progressing toward the high side
4. Second rolling, same procedure as 3.
6. Finish rolling

b) When paving in echelon, or abutting a previously placed lane, the mix shall be rolled in the following order:

1. Transverse joints
2. Longitudinal joints
3. Outside edge
4. Initial or breakdown rolling, beginning on the low side and progressing toward to high side.
5. Second rolling, same procedure as 4.
6. Finish rolling

c) When paving in echelon, 50 to 75 mm of the edge which the second paver is following shall be left unrolled, and rolled when the joint between the lanes is rolled. Edges shall not be exposed more than fifteen (15) minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in both intermediate and surface courses.

5.05 Breakdown Rolling

a) Breakdown rolling shall be accomplished with steel wheel rollers or approved pneumatic rollers. Breakdown rollers shall work as closely as possible behind the paving machine, without cracking the mat or having the mix pick up on the roller wheels.

b) Breakdown rolling shall start on the to low side of the spread, which is normally the outside of the lane being paved, and progress toward the high side. When adjoining lanes are placed, the same rolling procedure shall be followed but only after compaction of the fresh mix at the longitudinal joint with 150 to 200 mm of the roller width.

c) A pattern of rolling that will provide the most uniform coverage of the lane being paved shall be used. Normally, this pattern will involve overlapping on successive trips by at least one half the width of the narrowest wheel of the roller.

d) Breakdown rollers shall generally move onto the freshly laid mat with the drive rolls forward in the direction of paving.

5.06 Intermediate Rolling

a) Intermediate rolling shall follow the breakdown rolling as closely as possible while the asphalt mix is still plastic and at a temperature that will result in maximum density.

b) Normally, pneumatic tired rollers shall be used for the intermediate rollings. Pneumatic tired rollers shall be continuous, consisting of at least three (3) complete coverages.

c) Intermediate rolling shall follow the same rolling pattern as used for the breakdown rolling, and shall be continued until the desired compaction is obtained.

5.07 Finish Rolling

Finish rolling shall be accomplished with two-axle tandems while the material is still warm enough for removal of roller marks.

5.08 Correction of Surface Irregularities

If any irregularities or defects remain after compacting is completed, they shall be corrected in lower courses by removing or adding material. In the surface course the entire affected area of the surface shall be removed promptly and sufficient new material placed to form a true and even surface. All minor surface projections, joints, and minor honey-combed areas shall be rolled to a smooth surface. The final surface shall be of a uniform texture conforming to the line and grade as shown on the Design Drawing.

a) For situations where there is evidence of deficient asphalt pavement, a Certified Materials Testing Laboratory will be engaged by the developer to perform additional tests as required to make recommendations for remedial work which will be approved by the Municipal Engineer. All remedial work will be completed prior to acceptance of the road works.

5.09 Areas Inaccessible to Rollers

When the asphalt mix is spread in areas that are inaccessible to the rollers, compaction shall be obtained by hand tampers, mechanical tampers, or small vibrating-plate compactors.

5.10 Paving to Existing Curb and Gutter

When asphalt paving is being constructed against existing concrete curb and gutter, the finished surface of the asphalt pavement shall not be less than 5 mm above the top of the gutter.

5.11 Traffic Control

No traffic shall be permitted on the finished pavement until it has cooled to such temperature as to ensure that no deformation of the surface will occur.

6.0 Leveling Courses

6.01 Asphalt Mix

Asphaltic concrete mixes to be used in placing leveling course, or the placing of leveling wedges to correct sags and depressions shall be Class C.

6.02 Base Preparation

Leveling courses or leveling wedges shall not be placed on a base that has not been either primed or tack-coated in accordance with the Special Provisions of the Contract, and in accordance with Appendix 3 - Surface Preparation for Asphalt Paving.

6.03 Equipment

a) Self-propelled paving machines may be used. Where construction allows, a long ski riding on an adjacent lane, curb or gutter shall be used. A short ski or shoe grade follower shall be used in instances where a guide-line string is used as a grade reference. A grade reference string line shall be set by the Consulting Engineer to grade references elevation and shall be established parallel to the centre line of the road.

b) Motor grades may be used in laying leveling courses, or leveling wedges using only very skilled and experienced operators. When spreading leveling courses with a motor grader, such spreading shall be done to establish grade reference points as set by the Consulting Engineer.

6.04 Construction

a) In placing the mix in a leveling course with a motor grader it is essential to place the required amount of mix in each station of the work so that there will not be a large excess of material to waste.

b) The asphalt mixture shall be placed in a conventional trapezoidal windrow which shall then be spread by the motor grader in the normal fashion.

c) Ultimately, the asphalt mixture shall be spread from a windrow box to provide a flat spread 100 mm high and from 2 m to 2.5 m wide. The motor grader operator shall then "square blade" the mixture ahead.

d) When an automatic blade control is available on a motor grader, the blade shall be set to the required transverse slope and string line used to maintain longitudinal alignment.

e) Compaction of the asphalt mixture in leveling courses shall be done with a pneumatic tired roller following immediately behind the motor grader or paving machine.

6.05 Leveling Wedges

a) Leveling wedges shall be used to level sags or depressions in an old pavement prior to re-surfacing. Leveling wedges shall be placed in layers of not more than 75 mm in thickness. Where thicker wedges are required, multiple layers shall be used.

b) Where multiple layers are required, the Consulting Engineer shall establish sufficient levels to enable cross-section and profile to be established.

c) In placing multiple layers, the shortest length layer shall be placed first with the successive layer or layers extending over and covering the shortest layer.

6.06 Construction

The method of construction and compaction shall be the same generally as that specified in paragraph 6.04 and following procedural requirements of paragraph 6.05.

## 1.0 Scope

### 1.01 General

This Specification covers the materials, plant equipment and workmanship required for surface treatments of existing roads.

### 1.02 Description of Work

Surface treatments usually described as Seal Coats shall be referred to in this Specification as one of the following:

a) Aggregate Seal - single or multiple treatment
b) Sand Seal
c) Fog Seal
d) Slurry Seal

Additionally, Mixed-in-Place Surface Treatment and Plant-Mixed Surface Treatments shall be described under that particular application.

## 2.0 Materials

### 2.01 Methods of Test

a) Asphaltic materials shall be tested in accordance with methods of test designated in Appendix 7 - Methods of Test.

b) Mineral aggregates shall be tested in accordance with methods of test designated in Appendix 7 - Methods of Test.

### 2.02 Asphalt Primer

The asphalt primer shall be that specified by the Municipal Engineer. The asphalt specified shall conform to Appendix 1 - Asphaltic Materials.

### 2.03 Asphalt Binder

The asphalt binder shall be that specified by the Municipal Engineer. The asphalt specified shall conform to Appendix 1 - Asphaltic Materials.

### 2.04 Aggregates

a) For aggregate seals, the aggregate shall consist of clean crushed rock or gravel of uniform quality throughout. The aggregate shall have a percent wear by the Los Angeles Abrasion Machine Test of not more than forty (40), and not less than sixty (60) percent by mass of crushed gravel shall have two or more faces produced by fracture.

b) The aggregate shall meet the following gradation requirements:

| Size Number | Nominal Size Square Openings | Amounts finer than each laboratory sieve (square openings), percentage by weight | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 23.75 mm | 19.00 mm | 13.20 mm | 9.50 mm | 4.75 mm | 2.36 mm | 1.18 mm | 300 mm |
| 6 | 19.0 mm to 9.5 mm | 100 | 90 to 100 | 20 to 55 | 0 to 15 | 0 to 5 | | | |
| 7 | 13.2 mm to 4.75 mm | | 100 | 90 to 100 | 40 to 70 | 0 to 15 | 0 to 5 | | |
| 8 | 9.5 mm to 2.36 mm | | | 100 | 85 to 100 | 10 to 30 | 0 to 10 | 0 to 5 | |
| 9 | 4.75mm to 1.18 mm | | | | 100 | 85 to 100 | 10 to 40 | 0 to 10 | 0 to 5 |

Numbered sieves are those of the United States Standard Sieve Series, converted to metric by Canadian Government Specification Board Standard 8-GP-2M.

Or shall meet the following gradation requirements for one-sized aggregates:

GRADATION REQUIREMENTS FOR ONE-SIZE AGGREGATES

| Size Designation | Nominal Size Square Openings | Amounts finer than each laboratory sieve (square openings), percentage by weight | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 23.75 mm | 19.00 mm | 13.20 mm | 9.50 mm | 4.75 mm | 2.36 mm | 75 mm |
| A | 19.0 mm to 13.2 mm | 100 | 85 to 100 | 2 to 20 | 0 to 7 | | 0 to 1 | 0 to 0.5 |
| B | 14.25mm to 9.5 mm | | 100 | 85 to 100 | 0 to 30 | | 0 to 1 | 0 to 0.5 |
| C | 9.5 mm to 4.75 mm | | | 100 | 85 to 100 | 0 to 10 | 0 to 1 | 0 to 0.5 |

Numbered sieves are those of the United States Standard Sieve Series, converted to metric by Canadian Government Specification Board Standard 8-GP-2M.

c) For sand and seal slurry seals, the aggregate shall consist of clean, sharp sand and mineral filler, combined to meet the following gradation requirements:

| CGSB 8-GP-2M Sieve Size | Total Percent Passing |
|---|---|
| 2.36 mm | 100 |
| 1.18 mm | 55 - 85 |
| 600 um | 35 - 60 |
| 300 um | 20 - 45 |
| 150 um | 10 - 30 |
| 75 um | 5 - 15 |

d) Notwithstanding paragraphs b) and c), should the Contractor provide aggregates which meet the maximum size requirements, and such aggregates have a proven record of service and durability, the Consulting Engineer may approve the use of such aggregates in writing, although they do not meet the overall grading requirements specified.

## 3.0 Rates of Application

3.01 Rates of application or spread for asphaltic materials and the grade to be used shall be specified by the Consulting Engineer.

3.02 Rates of application or spread for aggregates and the gradation requirements to be used shall be specified by the Consulting Engineer.

3.03 Surface Preparation of Granular Base - Prior to surface treatment of granular bases, the base shall be prepared in accordance with Appendix 3 - Surface Preparation for Asphalt Paving, paragraph 6.0.

3.04 Surface Preparation of Existing Asphalt Surfaces - Prior to surface treatment of existing asphalt surfaces, defects in the existing pavement shall be repaired in accordance with Appendix 3 - Surface Preparation for Asphalt Paving, paragraph 7.0.

4.0 Construction Methods

4.01 Construction of Aggregate Seals

a) Subsequent to preparation under paragraph 3.0, the surface to be treated shall be swept clean using a rotary broom, and if dusty, the surface shall be dampened with water. Particular care shall be taken to thoroughly clean the outside edges of the area to be treated, and care taken that material removed shall not be mixed with the cover aggregate.

b) Asphaltic primer where specified shall be applied in accordance with Appendix 3 - Surface Preparation for Asphalt Paving, paragraph 6.0.

c) Following absorption and curing of the primer, application of the asphaltic binder shall be made uniformly at the specified rate using a pressure distributor. The binder shall be applied at a temperature such that the asphalt viscosity is within the range of twenty (20) to one hundred and twenty (120) centistokes for asphalt cements and liquid asphalts, or fifty (50) to one hundred (100) centistokes for emulsified asphalts.

d) The distributor shall be cleaned thoroughly before using unless its last use was with the same type of asphaltic binder specified for the work.

e) Applications of liquid asphalts (other than emulsified asphalts) and asphaltic cement shall be made only when the surface is thoroughly dry. Application of emulsified asphalt shall be made when the surface is dry or slightly damp.

f) Asphaltic binder (other than emulsified asphalt RS-2K) shall be applied only when the pavement temperature is twenty-six (26) degrees Celcius or higher. Emulsified asphalt RS-2K shall be applied only when the pavement temperature is ten (10) degrees Celcius or higher.

g) Before beginning application, building paper shall be spread over the surface, from the joint back, for a sufficient distance for the spray bar to begin spraying and be operating at full force when the asphalt surface to be treated is reached. The paper shall be removed after application of the asphalt.

h) The spray bar shall be shut off instantaneously at each construction joint to assure full application of the asphaltic binder up to the joint. Dripping shall be prevented by the insertion of a drip pan under the nozzles.

i) Areas unavoidably missed by the distributor, shall be touched up with a hand sprayer.

4.02 Application of Aggregate

a) Clean, dry aggregate shall be distributed uniformly by a mechanical or a self-propelled spreader and shall follow immediately the asphaltic application.

b) The cover coat shall be applied ahead of the truck or spreader wheels.

c) Immediately after spreading, the aggregate shall be rolled with a self-propelled pneumatic-tired roller having a total compacting width of not less than 1500 mm and minimum contact pressures of 275 kPa.

d) Rolling shall proceed in a longitudinal direction, beginning at the outer edges of the treatment and working towards the centre, with each trip overlapping the previous trip by one half the width of the front wheels, or roller.

e) The first rolling of the aggregate shall be completed within one-half hour after it has been spread, and rolling shall continue only until a smooth, thoroughly compacted surface is obtained.

f) In instances where the surface treatment is done one-half width at a time, 150 mm of the inside edge shall be left uncovered with aggregate to allow for an overlap of asphaltic binder when the remaining half of the surface is treated.

g) All loose aggregate shall be removed from the pavement following completion of the work.

4.03 Traffic Control

a) Traffic shall be kept off of freshly sprayed asphalt and shall be directed through the project with the least interruption of the work.

b) Should it be necessary to route traffic over the new treatment, speed shall be restricted to 8 km/h until completion of rolling and the asphalt has taken its initial set. Speed shall then be restricted to 40 km/h until the Consulting Engineer directs the end of traffic control.

4.04 Double and Multiple Surface Treatments

Where double and multiple surface treatments are specified, preparation and construction of subsequent treatments shall be done in accordance with paragraphs 3.04, 4.01, 4.02, and 4.03.

4.05 Construction of Sand Seals

Preparation, application and construction of sand seal surface treatments shall follow the procedures of paragraphs 3.04, 4.01, 4.02, and 4.03, with types of materials to be used and rates of application of material specified by the Consulting Engineer.

5.0 Fog Seals

5.01 General

This specification covers Fog Seal Surface Treatments to existing asphalt paving.

5.02 Surface Preparation

Prior to surface treatment of existing asphalt surfaces, defects in the existing pavement shall be repaired in accordance with Appendix 3 - Surface Preparation for Asphalt Paving, paragraph 7.01.

5.03 Materials

The emulsified asphalt to be used for this application shall be SS-1 or SS-1h, which shall be diluted with water at the rate of 1:1 parts emulsified asphalt to water.

5.04 Rate of Application

The rate of application shall be specified by the Consulting Engineer.

5.05 Construction Method

a) Subsequent to Surface Preparation under paragraph 5.02, the Fog Seal shall be uniformly applied using a pressure distributor at the rate specified by the Consulting Engineer.

b) The distributor shall be cleaned thoroughly before using unless its last use was with the same type of emulsified asphalt specified for the work.

c) Emulsified asphalt Fog Seal shall only be applied when the ambient temperature is not less than ten (10)° C.

5.06 Traffic Control

a) Traffic shall be kept off of freshly sprayed asphalt and shall be directed through the project with the least interrupion of the work.

b) Traffic shall be kept off of the freshly sprayed asphalt for two (2) hours following application of the seal, or until directed otherwise by the Consulting Engineer.

6.0 Slurry Seals

6.01 General

This Specification covers the application of Slurry Seal Surface Treatments to existing asphalt pavements.

6.02 Surface Preparation

Prior to surface treatment of existing asphalt surfaces, defects in the existing pavement shall be repaired in accordance with Appendix 3 - Surface Preparation for Asphalt Paving, paragraph 7.01.

6.03 Materials

a) Emulsified Asphalt shall be specified in the Special Provisions of the Contract.

b) Aggregate shall meet the requirements of paragraph 2.04c).

6.04 Equipment

a) For slurry sealing of small areas the mixture may be batched in a plaster machine, dumped on the surface to be treated and then spread with long-handled squeegees.

b) For large areas, slurry seals shall be mixed in transit mix type trucks and spread with a squeegee spread box towed behind the truck, or if available the mixture may be spread using a slurry seal machine.

6.05 Slurry Mixture

Unless otherwise specified in the Special Provisions of the Contract, materials shall be combined in the following proportions:

i) Combined aggregate and mineral filler - 50 kg.
ii) Emulsified asphalt - 15 litres.
iii) Water - as required for proper consistency.

In batching the mixture, approximately two-thirds (2/3) of the estimated water requirements shall be placed in the mixer. With the mixer operating, the aggregate is added in the specified proportion followed by the emulsified asphalt. The materials shall be added at a slow and uniform rate so as not to cause any balling or lumping in the mixture. The mixture shall be blended until uniform and shall be tempered with additional water if needed to produce a free-flowing creamy textured mixture.

6.06 Construction Method

a) Immediately prior to applying the slurry, the surface to be treated shall be dampened with a light application of water, except that no pooling of free-standing water shall occur on the surface. Following dampening of the surface, a tack coat of diluted emulsified asphalt shall be applied uniformly to the surface to be treated. The tack coat shall be of emulsified asphalt, the same type and grade specified for the slurry mix, diluted in the ratio of one part emulsified asphalt and three parts of water.

b) The tack coat shall be applied at the rate of 0.5 $L/m^2$, or as directed by the Consulting Engineer, and shall be thoroughly cured prior to the application of the slurry seal.

c) The slurry seal shall be spread on the area to be treated to provide a slurry thickness of the depth (specified by the Consulting Engineer).

d) The thickness for any one single course shall not exceed 5 mm.

e) Where the slurry seal is being applied over extensively scaled areas, each application shall be thoroughly rolled with a pneumatic tired roller after the slurry has cured.

f) The pneumatic tired roller shall be a total compacting width of not less than 1500 mm and shall have contact pressures of 275 kPa. The operating contact pressure shall be specified by the Consulting Engineer.

6.07 Traffic Control

All traffic control shall be kept off the slurry seal until it has cured to a firm condition that will prevent pick-up of the mixture. Where two applications of the slurry mixture are required, the initial treatment shall be cured thoroughly prior to placing the succeeding application.

1.0 Scope of Specification

1.01 General

This Specification covers the duties and responsibilities of the Consulting Engineer or his authorized representiative as set out in Section A1-3.

1.02 Testing Laboratory

The Consulting Engineer may appoint an independent testing laboratory to provide inspection services as directed, or to conduct testing of materials to ensure compliance with the Specifications.

1.03 Weather

No work shall be undertaken by the Contractor when, in the opinion of the Consulting Engineer, the weather is unsuitable or unfavourable for a particular class of work.

2.0 Inspection

2.01 Plant and Equipment

a) The Contractor shall at all times provide access to, and allow for inspection of the plant and all equipment during the Contract. Any deficiencies in plant or equipment, during either preparation of materials or subsequent construction shall be reported to the Contractor immediately and corrective measures shall be taken by the Contractor.

b) Should the Contractor not take remedial action to any request arising from paragraph 2.01 a), the Consulting Engineer shall order a stoppage of the work in progress until the necessary remedial action has been done by the Contractor.

2.02 Construction

a) During construction, the Contractor shall at all times comply with the methods of construction contained in this specification. Construction methods employed by the Contractor, which are at variance with the methods of construction shall be pointed out by the Consulting Engineer and remedial action, as may be directed, shall be taken by the Contractor.

b) Should the Contractor not take remedial action to any request arising from paragraph 2.02 a), the Consulting Engineer may order a stoppage of the work in progress until the necessary remedial action has been done by the Contractor.

c) At any time during construction, the Consulting Engineer, if of the opinion that the Contractor's construction method is inadequate and unlikely to provide pavement of the required density or surface finish, he may direct the Contractor to change his construction method or to supply alternative equipment, as may be directed.

d) The requirements of paragraph 2.02 c) shall in no way relieve the Contractor of his responsibility for obtaining the required degree of compaction and finish without directions from the Consulting Engineer.

e) Deficiencies in the finished pavement shall be corrected by the Contractor, where such deficiencies are at variance with the Standard Specifications.

f) All such corrctions shall be accomplished as directed by the Consulting Engineer at the expense of the Contractor.

3.0 Testing

3.01 Materials

a) As directed by the Consulting Engineer, the Contractor shall furnish samples, or provide access for sampling of materials.

b) Sampling of materials shall be in accordance with the pertinent specification as outlined in Appendix 7 - Methods of Test.

c) Testing of materials shall be in accordance with the pertinant specification as outlined in Appendix 7 - Methods of Test.

d) As required, for compaction testing purposes, the authorized representative shall obtain samples carefully removed from the completed pavement. Holes made by removal of such samples shall be carefully filled by the Contractor with the appropriate mixtures and thoroughly compacted to conform in every way with the adjoining undisturbed pavement.

4.0 Re-Testing

4.01 Failure to Meet Test Requirements

Should any tests, required by the Consulting Engineer, fail to meet the requirements of the Standard Specification, the Consulting Engineer shall direct re-testing to be done as he may deem necessary.

5.0 Inspection and Testing Costs

5.01 Inspection and Testing of Materials

Should an independent testing laboratory be appointed by the Consulting Engineer, the costs of inspection and testing services provided by the laboratory shall be paid by the applicant.

5.02 Re-Testing of Materials

a) Should re-testing of materials be required under paragraph 4.01, due to failure of materials to meet the Specifications, and such re-testing indicates compliance of the materials with the Specifications, the costs of such re-testing shall be paid by the applicant.

b) Should re-testing of materials be required under paragraph 4.01, due to failure of materials to meet the Specifications, and such re-testing indicates non-compliance of the materials with the Specifications, the costs of such re-testing shall be paid by the Contractor.

1.0 Test Requirements

All A.S.T.M. Specifications shall be read as the latest revision thereof.

| 1.01 Asphalt Cement | A.S.T.M. Specification |
|---|---|
| Viscosity | D2170 |
| Penetration | D5 |
| Flash Point | D92 |
| Thin Film Oven Test | D1754 |
| Rolling Thin Film Oven Test | D2872 |
| Ductibility | D113 |
| Solubility | D2042 |
| Specific Gravity | D70 |
| Softening Point | D2398 |

| 1.02 Liquid Asphalt | A.S.T.M. Specification |
|---|---|
| Viscosity | D2170 |
| Flash Point | D1310 |
| Distillation | D402 |
| Water in Asphalt | D95 |
| Specific Gravity | D3142 |
| Asphalt Residue of 100 Penetration | D243 |
| Ductibility | D113 |
| Solubility | D4 |

| 1.03 Emulsified Asphalt | A.S.T.M. Specification |
|---|---|
| Viscosity | D244 |
| Residue from Distillation | D244 |
| Settlement | D244 |
| Demulsibility | D244 |
| Sieve Test | D244 |
| Cement Mixing | D244 |
| Aggregate Coating-Water Resistance Test | D244 |
| Particle Charge Test | D244 |
| Storage Stability | D244 |
| Oil Distillate | D244 |

| 1.04 Mineral Aggregates | A.S.T.M. Specification |
|---|---|
| Sampling Aggregates for Use as Highway Material | D75 |
| Sieve Analysis: | |
| - Dry Sieve Analysis, Coarse and Fine Aggregate | C136 |
| - Mineral Filler | D546 |
| Sand Equivalent | D2419 |
| Abrasion (Wear) | C131 |
| Soundness Test | C88 |
| Specific Gravity: | |
| - Coarse Aggregate | C127 |
| - Fine Aggregate | C128 |
| - Filler | D854 or C188 |
| Unit Density | C29 |
| Moisture | C566 |

| 1.04 Asphalt Paving Mixtures | A.S.T.M. Specification |
|---|---|
| Sampling Bituminous Paving Mixtures | D979 |
| Marshall Test | D1559 |
| Density | D1188 or D2726 |
| Extraction | D2172 |
| Recovery of Asphalt | D1856 |
| Moisture and/or Volatile Distillates | D255 |
| Alternate Methods | D1461 |
| Maximum Specific Gravity | D2041 |
| Sieve Analysis of Extracted Aggregate: | |
| Coarse and Fine Aggregates | C136 |
| Mineral Filler | D546 |

| 1.05 Base Materials | A.S.T.M. Specification |
|---|---|
| Sieve Analysis - Dry Sieve Analysis: | |
| Coarse and Fine Aggregates | C136 |
| Sand Equivalent | D2419 |
| Abrasion (Wear) | C131 |
| Soundness Test | C88 |
| Proctor Density - Moisture Density | |
| Relations of Soils, Method A | D698 |
| Density of Soil in Place: | |
| Sand-Cone Method | D1556 |
| Rubber-Balloon Method | D2167 |

| 1.06 Distributor Spread Rate | State of California Divisions of Highways |
|---|---|
| Tentative Method of Field Test for the Determination of Distributor Spread Rate | No. Calif. 339-A - Tentative Test Method |

## 1.0 Ready-Mix Concrete

### 1.01 Reference Standards

Latest revision of all Reference Standards shall apply.

a) C.S.A. Standard A23.1 - Concrete Materials and Methods of Concrete Construction.
b) C.S.A. Standard A23.2 - Methods of Test for Concrete.
c) A.S.T.M. Specification C494 - Chemical Admixture for Concrete.
d) A.S.T.M. Specification C618 - Fly Ash for Use in Portland Cement Concrete.
e) C.S.A. Standard A5 - Porland Cements.
f) C.S.A. Standard A266.1 - Air-Entraining Admixtures for Concrete.
g) A.S.T.M. Specification C309 - Liquid Membrane Forming Compounds for Curing Concrete.

### 1.02 Inspection and Testing

a) All required sampling, preparation of specimens and testing shall be performed by an independent testing agency appointed by the Consulting Engineer. The testing agency shall report immediately to the Consulting Engineer when any procedure is contrary to the specifications and good practice.

b) Testing costs will be chargeable to the applicant.

c) The testing agency selected by the Consulting Engineer shall approve all mix designs.

d) The testing agency shall perform the following:

1. Supply cylinder moulds, sample the concrete, make and cure test cylinders and perform compressive strength tests in accordance with C.S.A. Standards A23.2.21, A23.2.14, and A23.2.13.

2. Make slump tests and air content tests in accordance with C.S.A. Standards A23.2.20 and A23.2.19 or A23.2.18 for each concrete test.

3. Take three (3) test cylinders for each 100 cubic metres or fraction thereof for each class of concrete placed in any one day, except that in no case shall a class of concrete be represented by less than three (3) tests.

e) The Municipal Engineer may at his discretion reduce or eliminate the test cylinders to be taken for minor pours or pours not of structural significance.

f) A compression strength test of one cylinder of each set shall be performed at the test specimen age of seven (7) days and copies of these test reports shall be forwarded to the Municipal Engineer and concrete supplier within fourteen (14) days of concrete placement.

g) Compression strength tests of the remaining two cylinders of each group shall be performed at the test specimen age of twenty-eight (28) days.

h) The 28-day strength test shall be defined as the average compressive strength of two (2) companion test specimens and copies of this test report shall be forwarded to the Municipal Engineer and concrete supplier within thirty-five (35) days of concrete placement.

1.03 Concrete Materials

a) Cement: Portland Cement shall conform to the requirements of C.S.A. Standard A5.

b) Water: Mixing water for concrete shall be clear and free from injurious amounts of oil, acid, alkali, organic matter, sediment, or any other deleterious substance.

c) Aggregates: Fine and coarse aggregates shall conform to C.S.A. Standard A23.1.5.

d) Admixtures:

1. AIR ENTRAINING ADMIXTURES: shall conform to the requirements of C.S.A. Standard A266.1.

2. WATER REDUCING AGENTS: shall conform to the requirements of A.S.T.M. Specification C494 (Type A). Accelerating or retarding admixtures of Types B, C, D, and E shall only be used with the authority of the Municipal Engineer, or his representative.

3. FLY ASH: shall conform to the requirements of A.S.T.M. Specification C618 - Class F. Fly Ash shall only be used with the authority of the Municipal Engineer or his representiative.

1.04 Concrete Mix Specifications:

| | |
|---|---|
| Cement | Type 10 or 30 |
| Compressive Strength @ 28 days | 30 MPa |
| Maximum Size Aggregate | 20 mm |
| Class of Exposure | Class A |
| Slump | 80 ± 20 mm |
| Air content | 6 ± 1 percent |
| Admixtures | * |

* Air entraining agents, water reducing agents and Fly Ash shall conform to the requirements of paragraph 1.03.

1.05 Concrete Mix Proportions

Concrete mixes shall be proportioned in accordance with C.S.A. Standard A23.1.9.2.1, Alternative No. 1, and the requirements of paragraph 1.04.

1.06 Concrete Quality

a) Concrete shall conform to the requirements of C.S.A. Standard A23.1.10.

b) Compressive Strength Requirements (C.S.A. Standard A23.1.10.5): The strength of the concrete shall be considered satisfactory if the averages of all sets of three compressive strength tests equal or exceed the specified strength and no individual test is more than 3.45 MPa below the specified strength.

1.07 Failure of Tests to Meet Requirements

If the results of tests indicate that the concrete is not of the specified quality, the Municipal Engineer shall have the right to enforce the provisions of C.S.A. Standard A23.1.10.6. Should additional testing indicate that the concrete is not of the specified quality, the Supplier shall remove the concrete in question at the Municipal Engineer's request.

Note: C.S.A. Standard A23.1.10.6.2. If, after carrying out the appropriate requirement of Clause 10.6.1, the Municipal Engineer is not satisfied that the concrete in the structure is of the specified quality, he may require a strengthening or replacement of those portions which he deems to be unsatisfactory.

1.08 Concrete Control

All concrete shall be "controlled concrete" in accordance with C.S.A. Standards A23.1 and as defined by National Building Code of Canada.

1.09 Measurement and Batching:

a) Materials for concrete shall be measured in accordance with C.S.A. Standard A23.1.11.1 and A23.11.2.

b) Batching of materials for concrete shall be in accordance with C.S.A. Standard A23.1.11.2.

1.10 Mixing and Delivering:

a) The concrete shall be mixed in accordance with C.S.A. Standard A23.1.11.3.

b) Delivery of concrete shall be in accordance with C.S.A. Standard A23.1.11.4.

1.11 Protection

a) COLD WEATHER REQUIREMENTS: Concrete shall be mixed and delivered in accordance with C.S.A. Standard A23.1.16.

b) HOT WEATHER REQUIREMENTS: Concrete shall be mixed and delivered in accordance with C.S.A. Standard A23.1.17.

c) Concrete Curing:

1. The surface of the concrete shall be protected by an approval membrane curing material which shall be applied to the entire exposed surface of the concrete immediately after the concrete has received its finish treatment.

2. The curing compound shall meet the requirements of A.S.T.M. Designation C309.

3. The membrane material shall be applied uniformly by an approved pressure distributor at an average of 5 square metres per litre. The compound when applied to a new concrete surface at the specified rate of application shall present a uniform appearance and shall effectively obscure the original colour of the concrete.

## 1.0 Scope

The work covered in this appendix of specifications pertains to the construction of portland cement concrete pavements in public rights of way within the Municipality.

## 2.0 Materials

Cement and other concrete materials, joint filler, curing materials and reinforcing steel, required by these drawings shall conform with the specifications of this Appendix.

### 2.01 Definitions

The definitions as described in CAN3-A23.1-M shall apply in these specifications.

### 2.02 Concrete Mix Specifications

| | |
|---|---|
| Cement | Normal Portland - Type 10 |
| Minimum Compressive Strength @ 28 days | 30 MPa |
| Minimum Flexural Strength @ 28 days | 4.2 MPa |
| Maximum Nominal Size Aggregate | 38 mm |
| Class of Exposure | A |
| Slump: Placed by Machine Method | 40 mm $\pm$ 10 mm |
| Placed by Hand Methods | 70 mm $\pm$ 20 mm |
| Air Content | 6 $\pm$ 1 percent |
| Admixtures | Air Entraining Agents |
| | Water Reducing Agents |
| | Fly Ash |

A mix shall be designed to meet the above criteria based on the water/cement ratio necessary to produce concrete of the specified strength, but in any case the water/cement ratio shall not be greater than that required for durability. Except as otherwise provided for on the drawings, the water/cement ratio (by weight) for air-entrained concrete shall not exceed 0.45 for the 30 MPa strength specified.

The weight of water used in determining the water/cement ratio referred to above is the weight of added water plus the weight of aggregate moisture. The added water shall be regulated to take account of the variations of the moisture content of the aggregates during a pour, so that at no time is the water/cement ratio given above exceeded.

The minimum cement content shall be 385 Kg per cubic metre of concrete.

The mix proportions proposed by the Contractor are subject to the approval of the Consulting Engineer, who shall call for such adjustments as he deems necessary. Notwithstanding the approval of the Consulting Engineer, it shall remain the responsibility of the Contractor to ensure the concrete meets all the requirements specified and he shall satisfy himself that in using the mix, these requirements will be met.

2.03 Cement

Cement shall be normal Portland cement (Symbol 10) conforming to CAN3-A5-M, or as approved by the Consulting Engineer.

2.04 Concrete Aggregate

Concrete aggregate shall conform to CAN3-A23.1-M. Concrete aggregate shall be a clean crushed stone or gravel and a natural well-graded sand.

2.05 Water

Water shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. If water is considered unsatisfactory it will be judged on the basis of comparison with distilled water. Change in time of setting of plus-minus 30 minutes or more in a standard cement test for setting time, or loss of 10 percent of strength in a cement mortar strength test when compared to results obtained using distilled water shall be sufficient cause for rejection of the water being tested.

2.06 Admixtures

Admixtures may be used only on the written authority of the Consulting Engineer. The Consulting Engineer will specify the control associated to the use of admixtures.

The use of calcium chloride and other accelerators is prohibited.

Air entraining agents, water reducing agents, and fly ash shall conform to the requirements of Appendix 8, Paragraph 1.03.

2.07 Curing Compound

Curing compound shall be spray applied, liquid type conforming to ASTM C309 (Liquid Membrane - Forming Compounds for Curing Concrete) containing a fugitive dye.

2.08 Joint Sealer

Joint sealer shall conform to ASTM D1190. Joint sealer shall be Para-plastic, hot-poured, rubberized asphalt joint sealing compound, Code 2350, or as approved by the Consulting Engineer.

2.09 Expansion Joints

Expansion joints shall be Flexcell, or as approved by the Consulting Engineer, of the same shape as the concrete cross sections and having a minimum thickness of 13 mm. Joint filler shall conform to ASTM D1751.

2.10 Sub-Base and Base Material

Sub-base and base material shall be as specified in Section R-2 and Appendix 2 of these specifications.

2.11 Reinforcing Steel

Reinforcing steel shall conform with the specifications of Section R-2, Paragraph 6.08.

3.0 Subgrade, Base Course and Sub-Base Preparation

The preliminary subgrade before the setting of forms shall be graded and compacted as required under Appendix 2. The cross sections shall conform to the following Municipal Standard Drawings:

| Standard Drawing Number | Road Classification |
|---|---|
| R-40 | Rural |
| R-41 | Residential |
| R-42 | Collector |
| R-43 | Major |

After the forms have been securely set to grade and alignment, the subgrade between the forms shall be brought to true cross section by dragging a subgrade template as many times as may be necessary to secure a true subgrade. The finished subgrade shall be brought to an unyielding surface by rolling with compacting units meeting the requirements in Appendix 2.

Where thickened edges for pavements are required, such as shown on the standard plans, the subgrade shall be excavated and shaped to provide for the section shown.

Wherever possible, vehicles shall be kept off the finished subgrade. If vehicles must travel on the subgrade ahead of the paving, a power drag shall be carried immediately ahead of placing concrete. Irregularities in the subgrade caused by trucks during the placement of concrete shall be smoothed out and compacted immediately ahead of placing the concrete.

No concrete shall be placed until the subgrade is approved by the Consulting Engineer. No concrete shall be placed on a frozen base. The subgrade as finally completed and approved shall be maintained by the Contractor at an optimum moisture content by wetting with water until the concrete is actually placed.

4.0 Forms

Forms may be of wood or metal or any other material at the option of the Contractor, provided the forms as constructed result in a pavement of specified thickness and cross section as shown on the following Municipal Standard Drawings:

| Standard Drawing Number | Road Classification |
|---|---|
| R-40 | Rural |
| R-41 | Residential |
| R-42 | Collector |
| R-43 | Major |

Steel forms may be used for tangents and for curves having a radius of 45 metres or more. Flexible forms shall be used for curves having a radius of less than 45 metres.

Forms shall be adequately supported to prevent deflection or movement and will result in concrete pavement conforming with the drawings and specifications. The top of the forms shall not deviate more than 3 mm in 3 m and the alignment of forms shall be within 6 mm in 3 m. The forms may be removed the day after pouring if the concrete is sufficiently set to withstand removal without danger of chipping or spalling. When forms are removed before the expiration of the curing period, the edges of the concrete shall be protected with moist earth or sprayed with curing compound. All forms shall be cleaned, oiled, and examined for defects before they are used again.

Steel forms shall be at least 3 metres long and have a depth at least equal to the thickness of the concrete pavement being placed. The metal thickness of the web in flange shall be at least 5 mm, and forms 200 mm or more in height shall be at least 200 mm wide at the base. Forms less than 200 mm in height shall have a base width at least equal to the height of the forms. The base plate and top of forms shall be true and at right angles to the face of the form and flanges securely braced. Each 3 metre form shall have at least 3 stake pockets.

Prior to placing concrete around manholes, catch basins, gate chambers, etc., a temporary cover fitting below the rim of the ring casting shall be provided to prevent the concrete from flowing into them.

5.0 Placing Concrete

The concrete shall be placed upon the prepared subgrade between the forms to the required depth and cross section as shown on the following Municipal Standard Drawings:

| Standard Drawing Number | Road Classification |
|---|---|
| R-40 | Rural |
| R-41 | Residential |
| R-42 | Collector |
| R-43 | Major |

The concrete shall be placed in a continuous operation between construction and expansion joints. The concrete shall be thoroughly consolidated against and along all forms or adjoining pavements by such means as will prevent gravel pockets along the edges of the finished pavement. Any gravel pockets found after removing the forms shall be repaired.

When integral curb is being constructed with the pavement, fresh concrete for the integral curb shall be placed at such time as will enable the top section of the curb to be consolidated, finished, and bonded to the pavement slab while the concrete is plastic.

Where curb is not being placed integral with the pavement slab, reinforcing steel dowels shall be placed in the base section for the curb. Dowels and keyways shall be placed in the pavement slab as detailed on standard drawings.

5.01 Placing Concrete At Expansion Joints

Concrete placement around expansion joints shall be such that the expansion joint assembly will not be disturbed and that it will remain in a straight line perpendicular to the subgrade, as shown on the standard plan. The concrete shall then be spaded thoroughly or vibrated along the entire length of the joint to consolidate the concrete and leave no rock pockets anywhere at the joint. If any rock pockets are exposed, they shall be repaired.

5.02 Placing Concrete With Reinforcing Steel Bars Or Wire Mesh

Concrete shall be placed in two courses. The first course shall be struck off at the elevation established for reinforcing steel bar or wire mesh, or as designated on the plans. Immediately prior to placing the reinforcement, the concrete shall be brought to a fairly even surface by means of a template conforming to the depth of the reinforcement.

Reinforcing steel bars or wire mesh shall be placed on the bottom course before the concrete attains initial set. No more than 45 minutes shall elapse between mixing of the first course and placement of the second course.

Reinforcement shall be free of dirt, mill scale, oil, grease or other foreign material that may impair bond. Steel, coated with rust, may be used if the oxidations are not deep or loose coated.

Successive mats of steel or wire mesh shall be securely lapped together and tied so that longitudinal bars will lap 40 diameters and wire mesh will lap 150 to 300 mm.

Reinforcing steel or wire mesh shall be laid as a continuous mat. Continuity shall be maintained between expansion joints. Steel shall terminate within 100 mm of the joint.

Concrete may be placed in one lift, provided a method is used to position and secure the reinforcing bars or wire mesh at the designated locations in the slab.

If the concrete is placed in two courses where reinforcement is used, all dirt, sand or dust which collects on the base course shall be removed before the top course is placed.

5.03 Slip Form Construction

At the option of the contractor and with the approval of the Consulting Engineer, concrete pavement may be constructed by the use of slip-form paving equipment.

Slip-form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape, and strength to support the concrete laterally for a sufficient period of time during placement to produce pavement of the required cross section; and the equipment shall spread, consolidate, screed, and float-finish the freshly placed concrete in such a manner as to provide a dense and homogenous pavement.

The concrete shall be distributed uniformly into final position by the slip-form paver and the horizontal deviation in alignment of the edges shall not exceed 13 mm from the alignment established by the Consulting Engineer.

Should the Contractor elect to use a slip-form paving machine that does not form an extruded curb, he will not be required to construct a depressed curb section at driveways. The driveway, when constructed may be poured against the back of the slip formed pavement. No payment will be made for the curb section that is not placed at the driveways.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels, and shall be offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

After the concrete has been given a preliminary finish by the finishing devices in the slip-form paving equipment, the surface of the fresh concrete shall be checked with a straight edge to comply with the tolerances and finish specified in Section 8.05 of this Appendix.

Final finishing of slip-form pavement shall be as specified in Section 8.04 of this Appendix.

6.0 Compacting Concrete

Concrete may be compacted by (1) hand methods, (2) machine methods and (3) combined machine and vibrators method at the option of the Contractor. The hand method will be limited to irregular areas, irregular sections and pavements placed in confined work areas.

6.01 Hand Compacting

Concrete shall be spread evenly with shovels and spaded along the forms with a perforated spade after which it shall be struck off with a metal shod tamping rod. The rod shall be cut to exact crown of the roadway and be fitted with handles at each end and be of such depth or trussed to be rigid. The strike-off rod shall be operated with a combined tamping, crosswise and sawing action to produce a smooth surface free from depressions or inequilties. A small amount of mortar must be kept ahead of and extending substantially along the entire length of the rod. Excessive swinging of the rod will not be permitted.

The concrete shall be struck off again with a "second strike rod" operated in the same manner as the first rod and following not closer than 6 m behind the first. The second rod may be eliminated on small pours of pavement of substandard width, unless use of the rod is required by the Consulting Engineer.

6.02 Machine Compacting

The machine used for compacting shall be self-propelled and designed to run on the side forms. Movable parts shall be capable of adjustment and they shall be adjusted so as to produce accurately the roadway sections shown on the plans. The machine shall be equipped with two reciprocating screeds. The tops of the forms shall be kept clean with a suitable device attached to the machine.

The machine shall be put in forward motion as soon as concrete is deposited on the subgrade. A roll of concrete shall be carried ahead of the screed. Screeds and tampers shall be operated so as not to disturb expansion joints and caps.

Machines shall be operated prior to placing longitudinal and transverse dummy joints.

Care must be exercised not to overwork the concrete and bring an excess of mortar to the surface.

6.03 Combined Vibration and Machine Compacting

The combined vibration and compaction equipment shall be demonstrated to the satisfaction of the Consulting Engineer as being capable of consolidating the concrete across the full width of the pavement into a homogeneous mass, free of rock pockets, and without separation of mortar and aggregates.

The equipment shall consist of the machine described in Section 6.02, Machine Compacting, or an approved spreading machine to which is attached a vibrating unit composed of individual internal vibrators spaced not more than 750 mm apart. The vibrators shall be spaced equidistantly, and the distance from the side forms to the nearest vibrator shall not exceed 350 mm. The vibrators shall be carried behind and independent of the strike-off screed of the spreading machine, or ahead of and independent of the strike-off screed of the first compacting machine.

The vibrating unit shall not rest upon the side forms nor impart vibration to the strike-off screeds. The individual vibrators shall be attached to a frame in a manner which will permit adjustment of both the depth of penetration into the concrete and the angle of the vibrator with the horizontal.

The entire vibrating unit shall allow raising the vibrator tips completely clear of the concrete surface.

The vibrators shall be capable of vibrating at rates between 4,800 and 8,000 impulses per minute when inserted in the concrete. All vibrators shall be synchronized to vibrate at a frequency specified by the Consulting Engineer, within the limits established.

On the first trip over the freshly placed concrete the vibration equipment shall be submerged in the concrete to ensure adequate consolidation. Unless otherwise directed by the Consulting Engineer, the vibration equipment shall be operated on the first pass only. The vibration equipment shall not be operated when the machine is not in motion except when vibrating near an expansion joint.

After the first pass with vibration, one or more trips without vibration shall be made as described in Section 6.02 of this Appendix.

6.04 Vibrating Screed Concrete Pavement Construction

The type of vibrating screed which the Contractor proposes to use, whether roller or beam, shall be subject to approval by the Consulting Engineer. Upon request by the Consulting Engineer a test section of pavement shall be placed for the purpose of demonstrating the capabilities of the screed to satisfactorily compact and strike off the concrete to the established grade and section.

Concrete shall be uniformly distributed between the forms and it shall then be compacted and screeded to the level of the top of the forms by means of the vibrating screed. Supplemental compaction by hand spading or mechanical vibration of the concrete adjacent to the forms will be required if the concrete cannot otherwise be adequately compacted.

The vibrating screed shall be operated over the freshly placed concrete in successive passes only a sufficient number of times to obtain maximum compaction. Over-vibration of the concrete, resulting in an excess of mortar at the surface of the pavement, will not be permitted.

After the final passage of the vibrating screed, the surface of the concrete shall be at the established pavement grade and cross section and shall be sufficiently smooth as to require only a very moderate amount of hand finishing for smoothness to meet approval of the Consulting Engineer.

7.0 Joints

7.01 General

A jointing layout design drawing approved by a Consulting Engineer shall be provided to the Contractor. Joints shall be placed as indicated on these drawings, and change from these locations shall only be made with the written approval of the Consulting Engineer. If the Contractor recommends changes in the jointing layout, he shall submit two copies of a drawing to the Consulting Engineer, showing his proposed revisions at least one week prior to the placing of concrete. The Consulting Engineer will return one copy of the drawing to the Contractor indicating either approval or rejection. Jointing shall then be undertaken in accordance with a drawing approved by the Consulting Engineer.

Transverse and longitudinal joints for street pavement may be contraction joints, construction or expansion joints as shown on the plans and as called for in these specifications. When the pavement abuts an existing pavement, the locations of the joints in the new pavement shall coincide with the joints in the existing pavement unless otherwise shown on the plans or specified in the special provisions.

7.02 Formed Transverse Contraction Joints

Standard spacing of transversely formed contraction joints along straight sections of streets between through expansion joints or between intersections or other irregular areas, shall be at intervals of 4.6 m across the full width of the pavement and at right angles to the center line of roadway. Where the spacing between through expansion joints are not in even multiples of 4.6 m for transverse joints, the last several spaces approaching the expansion joint or header shall be varied by shortening the spaces, as directed by the Consulting Engineer. On horizontal curves the spacing of 4.6 m shall be along the outer edge of the pavement.

For intersections and other irregular areas, the arrangement of contraction joints shall be placed in accordance with standard intersection patterns, or as directed by the Consulting Engineer. The area of any one irregular pattern formed by contraction joints in intersections shall not exceed 21 $m^2$ and the greatest dimension thereof shall not exceed 5 m.

When paving a second lane adjacent to the previously paved lane, the contraction joints shall be matched with the former; except on curves where resultant panel would be less than 3.8 m.

Where uncontrolled cracks are existing in the first lane, they shall be matched as nearly as possible in the second lane. Should the uncontrolled cracks in the existing paved lane be too frequent or in random locations and impossible to match with a uniform spacing in the second lane, then in that event the two lanes shall be completely separated by 5 mm joint material extending from the surface to 25 mm below the bottom of the concrete being placed.

Where full joint material is required to separate two paving lanes, its location shall be noted on the plans or in the special provisions and the cost thereof will be paid for at the unit bid price per linear meter.

Where integral curb or doweled curb is placed along with concrete pavement, premolded joint filler material shall be placed in the full section of the curb in true alignment with the pavement joint and in perpendicular position.

7.03 Construction of Formed Contraction Joints

Formed contraction joints shall be constructed by imbedding a preformed joint material. The filler shall be cut to the exact sections of the joint. The length of the premolded joint filler shall extend to within 6 mm of both edges of any panel. Formed contraction joints shall be formed by means of 'zip strip' as supplied by Demay Inc., or equal.

Transverse contraction joints shall be placed after compaction and finishing of concrete have been completed and before initial set. A groove shall be cut into the surface at the location of joint, using a tool provided with stops (tee iron) to prevent cutting the groove deeper than the planned depth of the joint filler. The joint filler shall then be forced into the groove until the top is flush with the pavement surface, with a deviation of not more than 3 mm below the surface. The joint filler shall be at right angles to the surface and always in a straight line.

After the joint filler has been imbedded in the concrete, the surface of the pavement shall be finished against the filler strip with hand floats to restore the surface finish. While performing this operation, the filler strip must be maintained in a vertical or normal position, true to alignment. After finishing, the entire area of the joint shall be true to grade and smoothness without any irregularities.

No payment will be made for contraction joint material or its placement, and all costs thereof shall be included in the unit contract price per square meter for "Cement Concrete Pavement".

7.04 Sawed Contraction Joints

Sawed contraction joints shall be constructed by sawing a vertical groove in the hardened concrete on an approved schedule after placing and before development of random cracks in the concrete slab. Transverse contraction joints shall be sawed before the longitudinal joints are sawed.

Sawed longitudinal joints in general are not critical as to a specific time schedule after hardening of the concrete and may be delayed under favorable conditions before an incidence of longitudinal random cracking begins. The Consulting Engineer shall direct the time schedule for sawing contraction joints.

Any scheduling for the sawing of joints that results in premature or uncontrolled cracking shall be revised immediately, under direction of the Consulting Engineer, by adjusting the time interval between placing of concrete and the sawing of joints. After the schedule has been approved, the sawing shall proceed as a continuous operation day and night until all joints have been completed.

Two or more sawing units may be required to accomplish the sawing in order to minimize random cracking. Standby equipment shall be on the job to ensure continuous sawing as specified regardless of any breakdown of equipment.

Where curing membrane is used, the area disturbed by sawing of joints shall be resprayed immediately upon completion of the sawing operation and care shall be exercised to prevent the curing compound from getting into the groove. Joint sealing compound will not adhere to concrete if curing compound is present.

The depth of sawed transverse contraction and longitudinal joints shall be either a minimum of 40 mm or not less than 1/4 the depth of the slab, whichever is the greater.

After the curing period the joints shall be cleaned and sealed with joint sealants meeting requirements in Section 2.08. Excess sealing material shall be cleaned off the surface of the pavement before opening to traffic.

7.05 Transverse Construction Joints

Transverse construction joints shall be made at the end of each day's paving, or when placing of concrete is discontinued for more than 60 minutes, by placing a header board transversely across the subgrade. The header board shall be located to conform to the spacing for the transverse contraction joints (or an expansion joint) and shall be left in place until the paving is resumed. If the location of the header board is to be a contraction joint, then the header shall have fastened to the concrete side a wedge-shaped strip of wood to form a key in the concrete. Thickened edge must be constructed at the construction joint header to provide ample depth of concrete above and below the keyway. Where preformed contraction joints are used, the joint made by the construction joint header shall have a 50 mm strip of joint material imbedded against the hardened concrete when paving is resumed.

Where sawed contraction joints are specified, the construction joint made by the header may be sealed or may have a 50 mm strip inserted as specified herein.

No separate payment shall be made for construction joints or for the premolded joint material, extra concrete, or sealing compounds required for the construction joints. All costs therefore shall be included in the unit contract price per square meter for "Cement Concrete Pavement".

7.06 Tranverse Expansion Joints

Transverse expansion joints are placed only where shown on the plans or where directed by the Consulting Engineer.

Transverse expansion joints shall be constructed with premolded material, 13 mm in thickness and conforming to Section 2.10. They shall extend the full width of the pavement and from 25 mm below the subgrade to 25 mm below the top of the pavement. The joint alignment must be at right angles to the pavement center line unless otherwise specified.

The filler material shall be held accurately in place during the placing and finishing of the concrete by a bulkhead, a holder, a metal cap or any other approved method. The joint must be at right angles to the paved surface and the holder must be in place long enough to prevent sagging of the material, especially on streets having steep grades.

In multiple lane construction, the joints shall be matched so as to form a continuous alignment over all lanes.

Expansion joints shall extend continuously through all curbs, special care being exercised to preserve alignment perpendicular to the pavement in the curb section.

A wood filler strip or metal cap shall be placed on the top of the premolded joint filler to form the groove 25 mm deep, and it shall remain in place until after the finishing and the concrete is sufficiently set to resist sloughing into the groove. The joint filler must be stapled together at the ends to preserve continuity.

Immediately after removal of side forms, the edges of the pavement shall be carefully inspected and wherever the joint filler is not fully exposed, the concrete shall be chipped down until the edge of the filler is fully exposed for the entire depth.

No additional payment will be made for expansion joint material or its placement. All cost therefore shall be included in the unit contract price per square meter for "Cement Concrete Pavement".

7.07 Sealing Expansion Joints

After the pavement is cured and before any traffic, the space above the top of expansion joint filler strip shall be thoroughly cleaned of all loose material. The groove 13 mm wide shall be completely free of any projecting concrete from the sides and the groove shall be continuous across the slab to each edge. It shall then be filled level with the pavement surface with joint sealant meeting the requirements of Section 2.08.

The joint sealant material shall be heated and placed in complete accord with the manufacturer's instructions. Burned material will be rejected. The expansion joint groove shall be dry at the time of pouring the sealing compound. No additional payment will be made for the sealing filler or its application and the cost thereof shall be included in the unit contract price per square meter for "Cement Concrete Pavement".

7.08 Longitudinal Contraction Joints

The joints shall be constructed in true alignment with respect to their proper location on center line or parallel thereto as is shown in a succeeding subsection. No payment will be made for contraction joint material and its placement.

7.09 Standard Location for Longitudinal Joints

Longitudinal joint spacing shall not exceed 3.8 m. Standard location for longitudinal joints, whether contraction or construction, shall be as shown below unless otherwise specified in the plans and special provisions:

| Road Class. | Std. Dwg. No. | Road Width | Joint Locations |
|---|---|---|---|
| Rural | R-40 | 5.0 m | Centerline |
| Residential | R-41 | 8.5 m | Centerline and 2m each side of center |
| Collector | R-42 | 11.0 m | Centerline and 3m each side of center |
| Major | R-43 | 14.0 m | Centerline and 3.5m each side of center |

In the event the roadway is divided into two lanes, the construction joints shall be located on the center line of the roadway unless otherwise approved by the Consulting Engineer. Construction joints on the center line shall be keyway types as shown on Standard Drawing Number R39.

7.10 Longitudinal Expansion Joints

Longitudinal expansion joints shall be placed where shown on the plans or where required for concrete pavement between or along retaining walls, curbs or other structures. Unless otherwise shown on the plans, longitudinal expansion joints shall be 13 mm thick and of a width equal to the full depth of the pavement.

The furnishing and placing of longitudinal expansion joints, using premolded joint filler material, shall be considered as incidental to the construction of the pavement and the cost thereof shall be included in other bid items of the work unless otherwise covered in the special provisions and proposal.

7.11 Longitudinal Construction Joints

Longitudinal construction joints shall be as shown on the standard drawings. The Contractor may use an approved keyed joint. The Contractor shall submit plans for the keyed joint for approval by the Consulting Engineer prior to construction.

8.0 Finishing Concrete

Hand finishing or machine finishing of the entire pavement surface will be permitted unless otherwise provided in the special provisions.

On all vertical curves and at irregular intersections, modified tools shall be provided as necessary to secure a smooth, uniform contour and surface.

All tools shall be kept in first-class working order and shall be inspected daily. Worn or defective tools will not be permitted. A sufficient number of tools shall be provided for the work to proceed efficiently.

8.01 Hand Finishing

After the concrete has been struck off and consolidated, it shall be smoothed by longitudinal floating. Movement ahead shall be in successive advances of not more than 1/2 the length of the float. Floating shall continue until all irregularities are removed. Longitudinal floating shall follow the compaction of the concrete by not less than 10 m. Free water on the pavement shall be removed with the float or other suitable tool.

After the final passage of the longitudinal float, transverse floating shall be continued with long handled floats operated from outside the pavement slab.

After floating, the surface shall be scraped with a grout rod at least 3 m in length with a long handle for operating at the edge of the pavement. The grout rod shall be operated to correct irregularities in the pavement surface and remove water and laitance. Contraction joints shall be placed after all floating has been completed in accordance with provisions of Section 7.02, Formed Transverse Contraction Joints.

8.02 Machine Finishing

The finishing machine shall be of a type approved by the Consulting Engineer. The machine shall be adjustable to both crown and plane of the finished pavement surface. The screed shall oscillate longitudinally during its travel transversely across the pavement. It shall be operated in the forward direction so that the screed will pass over the same section of pavement at least two times during its transverse travel.

The finishing machine shall be moved over the pavement as many times as is necessary to give the pavement a smooth even texture surface, conforming to the exact crown and cross section specified on the plans.

The floating shall not be considered complete until all free water is removed from the surface.

The finishing operations shall be performed at a time and over such lengths of the pavement surface as existing conditions necessitate. All finishing operations are subject to strict control by the Consulting Engineer, and shall be performed to his satisfaction.

The surface smoothness of the completed pavement shall be tested with a 3 m straightedge and shall meet the surface smoothness requirements specified in Section 8.05.

8.03 Edging

Before the final finishing is completed and before the concrete has taken the final set, the pavement shall be edged as indicated below.

| LOCATION | RADIUS |
|---|---|
| Edge of Pavement | 13mm |
| Formed longitudinal contraction joints | 6mm |
| Longitudinal construction joints | 6mm |
| Transverse construction joints | 6mm |
| Formed transverse contraction joints | 6mm |
| Through joints | 13mm |
| Curbs - back edge | 13mm |
| Curbs - front edge | 25mm |

Particular attention shall be given to edge at the appropriate time. The concrete shall have attained a partial set and all free water shall have disappeared so that the edged joints will be clearly defined, with no tearing or slump of the edges.

8.04 Final Finish

The pavement surface, after edging, shall be given a uniform, gritty texture true to grade and cross section. The final finish shall be accomplished by one of the methods described hereinafter, or as otherwise directed by the Consulting Engineer to achieve the specified surface texture.

Burlap Finish: A burlap drag at least one meter wide and the length of the pavement section shall be dragged forward over the pavement surface. The burlap drag shall be wet and clean when in use. The burlap shall not be left on the pavement surface between dragging operations.

Brush Finish: After edging, the pavement shall be brushed transversely with a fiber or wire brush of a type approved by the Consulting Engineer.

Before using either the drag or the brush, the concrete shall have set sufficiently that the surface is not grooved or gouged in the finishing operation.

8.05 Surface Smoothness

After all finishing is complete, the surface smoothness shall be checked with a straightedge 3 m long, mounted to a long handle to permit operation from outside the pavement. The straightedge shall be placed on the surface of the pavement parallel to the center line and at intervals of no more than 1.5 m across the full width of the pavement. At conclusion of the finishing operation the surface of the pavement shall not vary from a true surface, when tested with a 3 m testing straightedge, more than 3 mm in 3 m on majors, 3 mm in 3 m on collectors, 6 mm in 3 m on residential streets and rural roads.

In no case shall the grade in the gutter be such that it will allow ponding of water. If the surface smoothness of the pavement after curing is found to exceed the tolerance permitted, the high spots shall be ground until they meet the tolerance. If the surface tolerance cannot be met satisfactorily by grinding, then in that event the pavement shall be removed and be replaced in conformity with the specifications at the expense of the Contractor.

9.0 Curing and Protection

The concrete pavement shall be protected against excess loss of moisture, rapid temperature change, rain, water and mechanical injury during and immediately following the placing and finishing operations.

The concrete pavement shall be cured for the minimum number of days listed below, exclusive of the day the concrete is placed.

| | |
|---|---|
| Portland cement ..... | 5 days |
| High early-strength cement ..... | 3 days* |

*The use of High early-strength cement must be approved by the Consulting Engineer.

Moist curing by sprinkling or by saturated mats, liquid membrane or a combination of these may be used for curing medium and shall be applied in a manner and in quantity appropriate to the particular conditions as approved by the Consulting Engineer. Pavement edges which are exposed by the removal of the forms shall be protected by the immediate application of a curing medium or moist earth.

All curing materials shall be free of all substances which are considered to be harmful to portland cement. The curing medium shall be capable of preventing checking, cracking and dry spots regardless of conditions existing at the time of placement. Concrete placement will not be permitted unless curing materials are on the job site and ready for immediate application. Failure to comply with all provisions of the curing procedures hereinafter specified will be sufficient reason to suspend all concrete operations.

9.01 Sprinkler System

The sprinkler system shall keep the entire surface of the concrete pavement continuously wet, 24 hours a day. Care shall be taken to avoid damage to the surface of the pavement during placement of the equipment. The water flowing off the pavement shall be wasted in a manner satisfactory to the Consulting Engineer.

9.02 Saturated Mats

Cotton mats shall be placed over the entire area of the concrete pavement and kept saturated during the full curing period. The mats shall be lapped at all joints, and they shall be securely held in place to prevent displacement. The material which composes the mats shall conform to the standard specifications for AASHTO Designation M73, Cotton Mats for Curing Concrete.

9.03 White Liquid Membrane Curing Compound

White pigmented curing compound shall conform to the requirements in Section 2.07. The entire surface of the pavement shall be sprayed uniformly with sufficient compound to obscure the natural color of the concrete, but not less than one litre for each 4 square meters of area. The curing compound shall be applied immediately after the finishing is completed and all free surface water has disappeared, or after initial curing when other methods are used in combination with the liquid curing compound.

If hair checking occurs before the finishing operations are completed, the Consulting Engineer may require a fog spray as defined in Section 9.04. Any mortar scraped from the pavement surface shall be wasted. When it becomes necessary to fill depressions in the pavement surface, concrete shall be brought from the mixer. Whenever the pavement surface has been disturbed after the initial application of the curing membrane, it shall be restored by respraying.

The curing compound shall be applied with pressure spraying equipment having a feed tank equipped with a mechanically driven agitator and operated with sufficient air to properly atomize the compound.

If forms are removed from the pavement prior to the end of the curing period, curing compound shall be applied to the exposed surfaces within a period of one hour.

Curing compound shall not be applied either immediately before or after a rainfall. If the curing membrane is damaged by rain, it shall be restored to the original condition by respraying.

Provision shall be made for the Consulting Engineer to ascertain the rate at which the curing compound is being applied to the pavement. The compound shall be drawn directly from manufacturer's containers bearing the manufacturer's name, brand and lot number. Before placing the compound in the spray tank, it shall be agitated thoroughly to disperse the pigment. The compound shall not be diluted with solvent or altered in any way from its original condition. If the compound has become chilled, it shall be heated but not above 38 degrees Celsius.

After the compound has been applied, the curing membrane shall be protected against damage from any source, including traffic by foot or other. If any traffic is permitted, a protective cover approved by the Engineer shall be placed over the pavement not less than 24 hours after application of the compound.

The Contractor shall have readily available protective covering such as waterproof paper or plastic membrane sufficient to cover concrete pavement that can be placed in one full day.

The Contractor shall assume all liabilities for and protect the Owner from any damages or claims arising from use of materials or processes described therein.

9.04 Curing In Hot Weather

In periods of low humidity, drying winds, or high temperatures, a fog spray shall be applied to concrete as soon after placement as conditions warrant in order to prevent the formation of shrinkage cracks. The spray shall be continued until conditions permit the application of a liquid curing membrane or other curing media. The Consulting Engineer shall make the decision when the use of a fog spray is necessary.

10.0 Cold Weather Work

Concrete shall not be placed when the temperature is below 4 degrees Celsius, nor shall concrete be placed on a frozen subgrade. If, during a period of concrete placement and curing, the temperature is expected to drop to -1 degree Celsius within 24 hours in the opinion of the Consulting Engineer, all concrete not already cured for at least six days shall be covered with an insulating material in a manner and to a depth which will prevent freezing of the concrete. The insulating material shall be such that it will not stain or injure the concrete. The curing period shall be extended as much time as the Consulting Engineer may determine the conditions justify.

Concrete damaged by frost action shall be replaced at the Contractor's expense.

11.0 Concrete Pavement Construction In Single Lane

Concrete pavement may be placed in single lane full width or multiple lanes between longitudinal joints.

Concrete shall not be placed in a succeeding lane sooner than 48 hours after finishing of the first lane. Trucks shall be operated on the subgrade or on the shoulder adjacent to the lane being paved.

If the Consulting Engineer shall deem conditions to be such as to justify the operation of trucks upon newly paved concrete because of lack of space elsewhere, he may give permission to do so, but only under the following restrictions:

1. The concrete in the new lane shall have attained a compressive strength of 17 M Pa as determined by the Consulting Engineer.

2. The Contractor shall replace at his own expense any panels on the new pavement that are cracked or broken as a result of operating the trucks thereon.

3. A protective ramp shall be constructed at the pavement edge where vehicles may be driven on and off the pavement. The forms shall be left on the outside edge of the first lane at all turnouts until the pavement is opened to traffic.

When tie bars are specified, they shall be placed before the concrete is struck off during the last pass with the strike-off screed whether hand or machine operated. The tie bars shall be protected from traffic by bending down and back against the side form. Prior to placing the adjacent lane, the tie bars shall be straightened.

A metal strip 75 mm wide by 3 mm thick and at least 1.5 m in length shall be placed on the complete pavement lane near to the common joint with the adjacent lane to be paved, and the concrete placed in the adjacent lane shall be struck off from the plate, whether by machine or hand placement.

All roadways, shoulders, and subgrade in use by the Contractor shall be kept adequately dampened to prevent dust upon the freshly placed concrete.

12.0 Opening Pavements To Traffic

The Contractor shall not open newly constructed cement concrete pavement to traffic until the concrete has attained a compressive strength of 17 M Pa, as determined by the Consulting Engineer.

13.0 Cleanup

In addition to the cleanup specified in the construction of roads and sidewalks, Section R-2, Paragraph 9.0, the Contractor shall, before final acceptance of the work, flush the pavement clean and remove the debris. He shall also clean out all open culverts and drains, inlets, catch basins, manholes and water main valve chambers, within the limits of the project, of dirt and debris of any kind which is the result of the Contractor's operations. The cleaning and disposal of such waste material shall be considered as incidental to the construction and all costs thereof shall be included in the unit contract prices of various items of the work.

14.0 Concrete Inspection and Testing

All testing and inspection of concrete shall conform to the specifications of Appendix 8, Paragraph 1.02 with the exception that flexural strength tests may also be required at the discretion of the Consulting Engineer.

15.0 Concrete Quality, Mix Proportions, Control, Measurement, Batching, Mixing and Delivery

Concrete quality, mix proportions, control, measurement, batching, mixing and delivery shall conform to the specifications of Appendix 8, Paragraph 1.05, 1.06, 1.08, 1.09, and 1.10.

16.0 Failure of Tests to Meet Requirements

Appendix 8, Paragraph 1.07 will be applicable in the event that test results indicate that the concrete is not of the specified quality.

17.0 Measurement and Payment

Payment will be made for such of the following bid items as are included in any particular contract:

"Cement Concrete Pavement (class, thickness)," per square meter.
"Extra Concrete for Thickened Edge (cm x cm)," per linear meter.
"Steel Reinforcing Bars," per kilogram.
"Sawing Contraction Control Joints (depth)," per linear meter.
"Extra for Furnishing High-early-strength Cement," per tonne.

17.01 Cement Concrete Pavement

Payment for "Cement Concrete Pavement" shall be at the unit contract price for the specified class and thickness, complete in place.

Measurement for payment shall be by the square meter of concrete in place, including the area underneath curbs. No deduction will be made for castings in pavement.

The unit contract price shall be full compensation for subgrade preparation, furnishing of all labor, tools, equipment, materials excepting reinforcing steel, and for constructing, curing and protecting the cement concrete pavement.

All work, material and equipment not included in a separate unit contract price item shall be considered as incidental to the construction of the pavement and the costs thereof shall be included in the unit contract price per square meter of the cement concrete pavement.

17.02 Steel Reinforcing Bars

Steel required for pavement reinforcement will be paid for at the unit contract price for "Steel Reinforcing Bars" which shall be full compensation for furnishing and placing steel reinforcement as detailed on the construction plans. Measurement for payment will be by the kilogram of steel reinforcement in place.

Reinforcing steel shown on the standard drawings and required for ties of the pavement to driveway, curb, and curb and gutter will not be paid for under the item of "Steel Reinforcing Bars," per kilogram. Such steel shall be considered as incidental to the construction of the pavement and all costs thereof shall be included in the unit contract price per square meter of "Cement Concrete Pavement".

17.03 Sawing Contraction Control Joints

Measurement for payment will be by the linear meter of contraction joint sawed, cleaned and sealed in accordance with the plans and specifications.

The unit contract price per linear meter for sawing joints shall be full compensation for all labor, equipment and materials required to saw joints to the depth specified, and the unit contract price shall include all costs of labor and material for the sealing of the sawed joint as specified.

17.04 Extra for Furnishing High-Early-Strength Cement

If the Consulting Engineer shall direct that high-early-strength cement be used on any part of the work in lieu of standard portland cement, extra compensation will be made the Contractor in an amount per tonne equal to the difference between the price paid by him for standard port an ce ent an the price paid by him for high-early-strength cement.