1.0 GENERAL

1.1 Scope

1.1.1 The work shall consist of placing asphaltic concrete to a compacted thickness conforming to the lines, grades, and cross-sections as shown on the plan or as designated by the Engineer.

1.2 Related Sections

1.2.1 Section 2300 – Asphaltic Primer or Tack

1.2.2 Section 2325 – Supply of Asphalt Pavement

2.0 PRODUCTS

2.1 Materials

2.1.1 As specified in Section 2325 Supply of Asphaltic Pavement.

3.0 EXECUTION

3.1 Construction

3.1.1 The mixture shall be transported from the mixing plant to the work area in vehicles with tight metal bottoms previously cleaned of all foreign materials. When directed by the Engineer, the vehicle shall be suitably insulated and each load shall be covered with canvas or other suitable material of sufficient size to protect it from weather conditions. The inside surface of all vehicles may be lightly lubricated with a thin oil or soap solution prior to loading, but excess lubricating will not be permitted.

3.1.2 The mixture shall be laid with a mechanical self-powered spreader capable of spreading the mixture true to line, grade and crown as required. The paver shall be equipped with hopper and distributing screw of the reversing type to place the mixture evenly in front of adjustable screeds. The paver shall be equipped with an adjustable strike off screed of such design that drag marks will be eliminated and with built-in tamping bars for compaction during spreading.

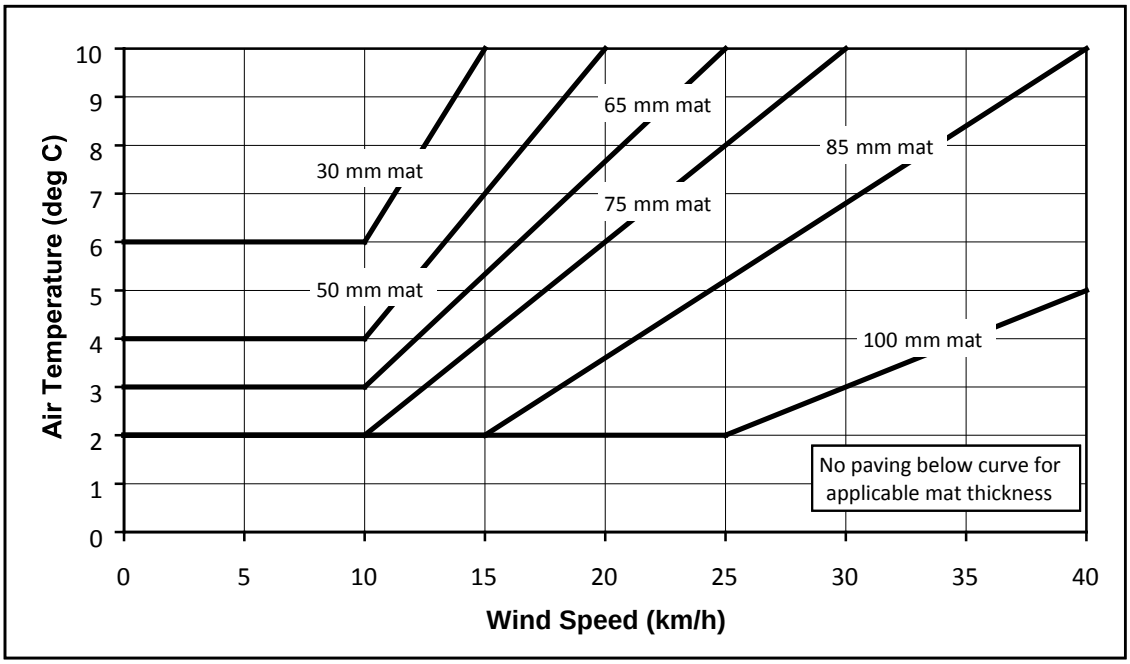
3.1.3 Paving will not be permitted if moisture or condensation is present on the ground surface.

3.1.4 Paving shall not take place when the ground temperature is less than 5°C or, if air temperature and wind speed conditions are below the applicable mat curve shown in the Figure 3.1, unless the Contractor can demonstrate using a rolling pattern that the specified densities can at these conditions. The rolling pattern must be approved by the Engineer. Regardless paving will not be permitted if the air

temperature is below 2^{O}C as shown on Figure 3.1.

3.1.5 As a guideline, the length of available rolling time for a given air and ground temperature, wind speed and mat thickness may be estimated using the PaveCool application, available for download at http://www.dot.state.mn.us/app/pavecool/ or other similar software. The actual mat temperatures shall be monitored and recorded by the Contractor during placement in cool weather.

Figure 3.1 – Guidelines for Air Temperature and Wind Limitations on Paving



3.1.6 The mixture shall be laid and rolled to the widths and thicknesses shown on the drawings or as directed by the Engineer. The finished surface shall have the minimum number of longitudinal and transverse joints practicable.

3.1.7 The minimum lift thickness of hot mix asphalt shall be 3 times the nominal maximum aggregate size for fine graded mixes and 4 times the nominal maximum aggregate size for coarse aggregate mixes. The recommended maximum lift thickness is as per Section 2325, HMA Selection Guide. The maximum recommended lift thickness may be exceeded providing the pavement specified density is achieved. The second lift shall not be placed over the bottom layer until the temperature is 60 ^{o}C or less. Before rolling is started, the surface shall be checked, inequalities in depth adjusted and any flushing, bleeding, fat spots or sandy accumulations replaced and irregularities in alignment or grade along the outside edge shall be corrected.

3.1.9 A constant supply of hot asphalt must be supplied to minimize transfer joints. Otherwise, if the temperature of the un-compacted mat cools, the Contractor shall cut back the mat to the graded and compacted area.

3.1.10 When approved by the Engineer, areas inaccessible by the spreader machine or irregular in shape may be paved by other methods. Hand raking shall be done sparingly to minimize rock segregation.

3.1.11 Except when otherwise required to fill the complete concrete gutter section, remove asphalt entirely from the gutter section and round out the edge of the asphalt mat adjacent to the face of gutter before the mat is rolled or compacted.

3.1.12 A continuous well-sealed bond is required between old and new surfaces. The contact surface of all longitudinal and transverse joints shall have a thin, uniform coat of hot asphalt tack applied before placing the hot asphalt. Where the asphaltic concrete material is placed in two layers, longitudinal joints in the two layers shall be staggered by a minimum of 150 mm.

3.1.13 When matching a longitudinal joint to a previously laid mat, an overlap of not less than 25 mm or more than 75 mm shall be made. The depth of the newly placed mat should be enough so that subsequent compaction after rolling will align to the level of the adjacent mat.

3.1.14 When possible, paving in echelon (two pavers moving in a staggered fashion) is recommended.

3.1.12 The rollers shall be kept in continuous motion while on the hot mat in such a manner that all parts of the pavement receive equal compression and prevent static roller depressions.

3.1.13 The rollers shall proceed in a suitable manner to allow for proper compaction and density. Unless otherwise directed by the Engineer, vibration may be used to obtain compaction.

3.1.14 Where new pavement structure abuts the existing pavement surface that is 100 mm thick or greater, the Contractor shall cold plane 50 mm of existing surface for a distance of a minimum two (2) metres to allow the top lift to be placed across the construction joint. The end of the milled joint shall produce a straight line across the paved surface with a vertical face to pave to. For existing pavement surfaces less than 100 mm thick, sawcutting is acceptable. The finished surface across the joint shall be smooth, such that when a three (3) metre straight edge is placed across the joint, no gaps appear between the straight edge and the pavement edge.

3.1.15 Areas inaccessible to the roller shall be compacted by tamping with mechanical or hand tampers.

3.1.16 The breakdown rolling shall take place as closely behind the laying machine as the temperature and condition of the mat will allow. If used, pneumatic tire

rolling will be made with the tire pressure at a level such that only light rutting is evident. Maximum densities are attained when tire pressures are raised as rapidly as the mix stability will permit. Pneumatic rolling shall continue until two complete coverages have been made by the roller with the tire pressure at 850 kPa for collector, industrial and arterial roads and 600 kPa for residential roads.

3.1.17 After final rolling of the surface course, the asphalt shall meet the gutter at an elevation of 10 mm above and along the entire lip of the gutter except on the high side of super-elevation curve where it shall be flush with the lip of the gutter. Final rolling shall be carried on until all roller marks are eliminated and no further compaction is possible.

3.1.18 Sufficient rollers must be maintained on job site to insure full compaction of asphalt mix before temperature of mix falls below 95 °C.

3.1.19 The asphaltic finished surface shall be true to the required profile and cross-section, with a tolerance of ± 5 mm from the required elevations. The finished grade shall neither be consistently high or low from the design grade. The surface shall show no depressions or bumps exceeding 5 mm under a straight edge three 3 m (minimum) long, placed parallel to the road centre line. Where specified in contract documents, surface smoothness pay adjustment will be made in accordance with the methods employed by the Ministry of Highway and Transportation Department.

3.1.20 Where water valve boxes or manholes are rebuilt, constructed, lowered and/or adjusted in conjunction with surface construction or renewal, adjust the appurtenances such that the top surface of the appurtenance is flush with the finished grade of the pavement, sidewalk or boulevard.

3.1.21 After placing, rolling and compacting the asphalt, depressions or bumps measured centerline to the top of the appurtenances under a straight edge, a minimum of 3 m long, placed parallel to the road are not to exceed:

APPURTENANCE	DEPRESSION	BUMP
Water valve boxes	10 mm	5 mm
Floating manholes	5 mm	5 mm
Solid manholes	10 mm	5 mm

3.1.22 Any uplifting or settlement of water valve boxes and/or manhole frames shall be corrected to conform to this specification.

3.1.23 Core density values shall govern over nuclear density. In the event that an area is removed and replaced, or of low density receiving additional compaction, the area shall be re-cored and retested with a new calibration

factor applied to the nuclear results.

3.1.24 The completed pavement shall have an average density of ninety-three to ninety-six percent (93% to 96%) of the Theoretical Maximum Density/Theoretical Specific Gravity (TMD/TMG). Should an individual test be less than ninety-one percent (91%), the Contractor shall re-compact the area to obtain a minimum of 93%.

3.1.25 No traffic shall be allowed on the finished surface until it has cooled to 52^{o}C or until permitted by the Engineer.

3.1.26 The Contractor shall ensure no asphalt is left on utility covers and tops, or gutters, or falls into existing utilities located in the paving area. The Contractor shall be responsible for all clean up and clearing of asphalt debris that is left on or enters into the existing utilities at no cost to the Owner.

3.2 Material Testing Requirements for Quality Control

3.2.1 In accordance with ASTM D2950, Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods. A Marshal sample shall be taken at a minimum of every 400 tonnes and at least one per day

3.2.2 Perform a minimum of one density test per 250m^2 per compacted lift. Testing location to be selected by the testing agency under the direction of the Engineering. Field density will be tested using one or more of the following methods as deemed appropriate by the testing agency:

.1 The use of Electromagnetic Surface Contact Methods (Pavement Quality Indicator (PQI) to measure density of Bituminous paving mixtures in place - ASTM D7113-16 is permitted.

.2 Three to Five (3 to 5) tests are to be taken at each site. The results are to be averaged and reported as the in-place density. Field cores must be taken to confirm and calibrate the PQI. Field core results must accompany field test readings taken by the PQI.

3.2.3 Core samples for density and thickness shall be taken every 500 m^2 and shall be used to calibrate the nuclear density results. Quality Control testing for density and core measurements shall be completed within seven (7) days of the completed paving. The calibrated density values shall be submitted to the Engineer within fourteen (14) days of the completion of the paving.

3.3 Completion Inspection and Acceptance Criteria

3.3.1 The finished asphalt surface shall be free of but not limited to: segregation, pop outs, stripping, roller marks, cracking, tearing and excess or insufficient asphalt cement.

3.3.2 Deficiencies will be determined by the Engineer along with the remedy(s). Where the Contractor must remove and replace any deficiencies they must follow the standard procedures for placement and testing as described below. Prior to completing any remedies the Contractor shall submit a work plan to the Engineer for review and approval.

3.3.3 A pay reduction or repair shall be required according to the definition and calculations in Table 3-1, Table 3-2 and Table 3-3.

3.3.4 Unless otherwise noted below, the minimum area for penalty shall be the greater of: the full width of the paved lane (minimum 3.6m) times a minimum length of 20 lineal meters, or the actual deficient area.

Table 3-1 – Thickness Pay Reduction

THICKNESS DEFICIENCY (mm)	PAY FACTOR (%) NEW CONSTRUCTION	PAY FACTOR (%) REHABILITATION CONSTRUCTION
Up to 3	100	100
3 to 5	98	100
6	95	95
7	90	90
8	80	80
9	70	70
10	50	50
Over 10	Remove and replace	Remove and replace

* The average asphalt concrete thickness must meet or exceed the required thickness.

* If any individual core thickness is less than the required thickness the minimum area for pay reduction shall apply.

* No additional payment for asphalt thickness overages will be made.

Table 3-2 - Density Pay Reduction

COMPACTED DENSITY % OF THEORETICAL MAXIMUM DENSITY (TMD)	PAY FACTOR (%)
93.0 to 96.0	100
92.6 to 92.9	90
92.0 to 92.5	85
91.6 to 91.9	80
91.0 to 91.5	75
Less than 91%	Remove and replace

* If a core density on any individual test is less than 91%, a pay reduction of 90% will be applied to a minimum area of 100 m².

* No payment for densities in excess of the specified density shall be made.

Table 3-3 – Deficiency Pay Reduction

Deficiency Item	**Action Required**	**Corresponding Pay Reduction**
Clay ball pop-out	▪ Core hole and remove pop-out and repair with asphalt concrete	Must be repaired
Minor Segregation: Matrix, asphalt cement and fine aggregate is in place between the coarse aggregate. However, there is more stone in comparison to the surrounding acceptable mix.	▪ No repair required on any lift ▪ Deficient areas on top lift measured and penalty applied. ▪ Fog seal.	25% pay based on deficient surface area.
Moderate Segregation: Significantly more stone that the surrounding mix; moderately segregated areas usually exhibit a lack of surrounding matrix.	▪ No repair required on lower lifts. ▪ Top Lifts - Deficient areas measured and penalty applied. ▪ Slurry seal or micro-surfacing.	50% pay based on deficient surface area.
Severe Segregation: Asphalt appears as an area of very stony mix, stone against	▪ Remove and replace or overlay of top lift. ▪ No repair on lower lift	Must be repaired

stone, with very little or no matrix.	required if the Engineer deems there is no effect to the structural integrity. ▪ Top lift must be repaired by milling and replacing a minimum of 40 mm for the entire lane width.	
Cracking, Tearing or Waves	Deficient areas measured ▪ Penalty applied, or ▪ Remove and replace	50% pay based on deficient surface area
Stripping or Ravelling	▪ Remove and replace, or ▪ Surface treatment based on severity. ▪ Mill and replace a minimum of 40 mm for the entire lane width if severity is moderate or severe; or micro-surfacing if severity is minor or moderate.	Must be repaired
Joint deficiency	Length of joint measured ▪ Penalty applied	Reduction of $ 15.00 / lineal metre of deficient joint
Excess or insufficient asphalt cement	Deficient areas measured ▪ Penalty applied, or ▪ Remove and replace, or ▪ Surface treatment based on severity	50% pay based on deficient surface area
Roller marks	Length of roller marks measured ▪ Penalty applied	Reduction of $ 15.00 / lineal metre of mark
Uneven Water Valve or Manhole	Depression or bump	$2,000 each
Rutting: Rut measurements shall be taken 12 months after placement of asphalt. Depth shall be measured by placing a straight edge three (3) metres long across the rut perpendicular to the road centre line.	Less than or equal to 5 mm: no repair required.	No penalty.
	Between 5 mm and 12mm: mill and replace minimum 40 mm depth or rut fill with micro-surfacing treatment full lane width.	Repair or reduction of $40 per lineal meter per lane width.
	Greater than 12mm: Mill and replace minimum 40 mm depth full lane width.	Must be repaired.

3.4 Asphalt Surface Treatments

3.4.1 The following are deemed to be acceptable methods of surface treatment to be used for asphalt repairs:

3.4.1.1 A fog seal is a light application of diluted slow setting asphalt emulsion to the asphalt surface to seal the surface.

3.4.1.2 A slurry seal is a designed mixture of aggregate, additives (as needed), emulsified asphalt, and water applied to a prepared pavement as a surface treatment.

3.4.1.3 Micro surfacing is a designed mixture of crushed aggregate, additives (as needed), polymer-modified emulsified asphalt, additives and water applied to a prepared pavement as a surface treatment.

3.4.1.4 The Contractor may submit alternate surface treatments to the Engineer for review. The proposed surface treatments must have a proven minimum life of five years.

3.4.2 Aggregate

3.4.2.1 The aggregate shall be composed of sound, hard and durable particles of sand, gravel and/or rock; and shall be free from elongated particles, injurious quantities of flaky particles, soft shales, organic matter, clay lumps and other foreign matter. Gradation of the aggregate shall be as shown in the following table unless otherwise approved or directed by the Engineer:

Sieve Designation (mm)	Percent Passing	
	Slurry Seal	Microsurfacing
9.5		100
4.75	100	90-100
2.36	90-100	65-90
1.18	65-90	45-70
0.600	40-65	30-50
0.300	25-42	18-30
0.150	15-30	10-21
0.075	10-20	5-15
Plasticity	Non-plastic	
Sand Equivalent	Minimum 45	

3.4.3 Additives

3.4.3.1 Additives, when required, shall be supplied by the Contractor. The Contractor shall arrange delivery, store and handle additives.

3.4.4 Mineral Filler

3.4.4.1 Mineral filler may be used to improve mixture consistency and to adjust mixture breaking and curing properties. Portland cement, hydrated lime, limestone dust, fly ash or other approved filler meeting the requirements of ASTM D 242 shall be used.

3.4.5 Asphalt

3.4.5.1 The Contractor shall supply asphalt material. The asphalt binder used for slurry seal shall meet the requirements ASTM D 2397 for CCSS-1, CSS1h or CQS-1h.

3.4.5.2 The asphalt binder used for micro-surfacing shall be cationic polymer modified emulsified asphalt binder shall meet the requirements of and ASTM D 244 for CQS-1HP or CSS-1HP. The polymer shall be a minimum of 3% polymer solids by mass of asphalt cement residue.

3.4.5.3 The same asphalt chosen for the slurry seal or micro-surface binder shall be used for tack and fog coat applications.

3.4.6 Water

3.4.6.1 The Contractor shall supply suitable water.

3.4.7 Mix Design

3.4.7.1 The Contractor shall prepare and submit a mix design to the Engineer for review.

3.4.7.2 The mix design shall follow ASTM D3910, Standard Practice for Design, Testing, and Construction of Slurry Seal. The residual asphalt content shall generally be between 10.0 and 16.0 % for slurry seal and 5.5 and 10.5% for micro-surfacing. The mix design shall also contain the following information:

(a) gradation of aggregate to be used,

(b) the design proportions of each component including additives,

(c) other characteristics of the aggregate specified above,

(d) all test results used in producing the mix design.

3.4.8 Weather Limitations

The slurry seal or micros-surface shall not be applied when:

(a) The atmospheric or pavement temperature is less than 10 degrees Celsius and falling,

(b) The weather is misty or rainy,

(c) Precipitation is a threat for the construction area within twelve hours as forecast by Environment Canada for the vicinity, or

(d) An atmospheric temperature of less than 5 degrees Celsius is predicted by Environment Canada within twenty-four hours.

3.4.9 Surface Preparation

The Contractor shall remove all surface painted markings in areas where seal is to be applied. The method and equipment used by the Contractor shall be such that no structural damage is caused to the existing pavement.

Repair of existing surfaces, including crack filling, prior to sealing will be identified by the Engineer and the required repairs shall be carried out by the Contractor.

The pavement surface to be sealed shall be swept and all dirt, dust, and other objectionable matter removed.

If specified by the Engineer, tack coat shall be applied in accordance with Section 2300 for Asphaltic Prime or Tack Coat. Tack coat shall be applied at a rate of between 0.2 – 0.4 L/m^2.

3.4.10 Trial Area

A trail area shall be selected at the start of the operation by the Engineer and be at least 50 m in length and one lane wide to demonstrate the ability to produce a consistent and uniform surface. The Engineer will inspect the trial area for conformance to the specification prior to proceeding. Trial areas shall be repeated until the requirements are met.

3.4.11 Application

The surface to be sealed, including tacked surfaces if specified, shall be wetted immediately before application of the slurry seal. Unless otherwise specified by the Engineer, surface treatment seal shall be applied at a rate of between 4.3 – 6.5 kg/m^2.

The surface shall be damp, but no standing free water will be permitted.

The surface treatment shall be deposited in a continuous flow from the mixer into a controlled spreader box.

The surface treatment shall be applied in the direction of the longitudinal axis of the area to be sealed unless otherwise directed by the Engineer. The application shall be uniform and homogenous with no uncovered areas, ridges or loose aggregate. Emulsion shall not exceed a temperature of 40^o C when applying.

The surface treatment shall be mixed in continuous flow travelling mixers capable of delivering predetermined proportions of emulsion, water and aggregate. Each mixer shall be equipped with feeders that provide accurate metering devices or methods of

introducing predetermined amounts of additives when the aggregate is fed. Calibrated controls for aggregate and asphalt emulsion, capable of proportioning accurately, shall be provided.

Ruts less than 13 mm depth may be filled using micro-surfacing. A full width scratch course may be applied using the spreader box. All rut filling and levelling courses shall be allowed to cure under traffic for a minimum of 24 hours before additional material is placed.

The spreader box shall have flexible squeegee strike-off strips on each side maintaining contact with the surface to be sealed. The flexible strike-off strips shall make close contact with the surface and shall be adjustable to the various slopes of the surface to be sealed. The box shall contain baffles or other suitable means to help in lateral distribution of slurry and to provide uniform application.

Surface treatments shall be applied in the direction of the longitudinal axis of the area to be sealed unless otherwise directed by the Engineer. The application shall be uniform and homogenous with no uncovered areas, ridges or loose aggregate.

Hand squeegees shall be used to spread slurry seal in areas not accessible to the mixer. The Contractor shall protect manholes, valve boxes and bridge expansion joints from application of slurry seal during spreading operations. Spillage shall be removed with hand tools before initial set of the mix

The longitudinal and transverse joints shall be neat and uniform in appearance, with no excessive build-up. Longitudinal joints shall be placed on lane lines.

The longitudinal joints in the scratch coat shall be constructed as a butt joint.

The longitudinal joint in the surface course shall have an overlap of 50 to 100 mm.